USER'S MANUAL

PROCESS CONTROLLER

CH SERIES

UK

ManCH-UK Vers 1.3 May'09

WARNING

- **If failure or error of this instrument could result in a critical accident of the system, install an external protection circuit to prevent such an accident**

- **Do not turn on the power supply untill all of the wiring is completed. Otherwise electric shock, fire or malfunction may result.**

- **Use this instrument within the scope of specifications. Otherwise fire or malfunction my result.**

- **Do not use this instrument in the place subject to flammable or explosive gas.**

- **Do not touch high-voltage blocks such as power supply terminals, etc. otherwise electric shock my result.**

- **Never disassemble, repair or modify the instrument. This may cause electric shock, fire or malfunction.**

- ***Over-temperature protection*: Any control system design should take into account that any part of the system has the potential to fail. For temperature control systems, continued heating should be considered the most dangerous condition, and the machine should be designed to automatically stop heating if unregulated due to the failure of the control unit or for any other reason. The following are the most likely causes of unwanted continued heating:**
  - **Controller failure with heating output coinstantly on**
  - **Disengagement of the temperature sensor from the system**
  - **A short circuit in the thermocouple wiring**
  - **A valve or switch contact point outside the system is locked to keep the heat switched on.**

  In any application where physical injury or destruction of equipment might occur, <u>we recommend the installation of independent safety equipment, with a separate temperature sensor, to disable the hetaing circuit in case of overheating</u>.
  <u>The control alarm signal is not designed to function as a protective measure in case of controller failure.</u>

CAUTION

- **This is a Class A instrument. In a domestic environment this instrument may cause radio interference, in wich case the user is required to take adequate measures.**

- **This instrument is protected from electric shock by reinforced insulation. So please arrange reinforced insulation to the wire for input signals against the wire for instrument power supply, source of power and load as far as possible.**

- **This instrument is manifacured on the assumption that it is used in the condition of being mounted on the instrumentation panel. Therefore, take the necessary measures on the equipement side mounted with this instrument so that the operator personnel are not accessible to high-voltage blocks in this instrument such as power supply terminals.**

- **Always observe precautions described in this manual. Otherwise serious injury or accident may result.**

- **Conduct all of the wiring in accordance with the local codes and regulations.**

- **Install a protection device as fuse, etc. in the power supply, input or output line if necessary.**

- **Do not allow metal fragments or lead wire scraps to fall inside this instrument. This may cause electric shock, fire or malfunction.**

- **Firmly tighten each terminal screw at the specified torque. Otherwise electric shock or fire my result.**

- **Do not place any obstacle around this instrument in order not to impede radiation of heat. And do not close ventilation holes.**

- **Do not connect wires to unused terminals.**

- **Please apply appropiate power source to instrument according to rated power show on label over instrument: a wrong power supply could damage the instrument and my cause short circuit or burn out.**

- **Before cleaning the instrument, always turn off the power supply.**

- **Remove stains from this instrument using a soft, dry cloth. Do not use a volatile solvent such as thinner in order to avoid deformation or decoloration.**

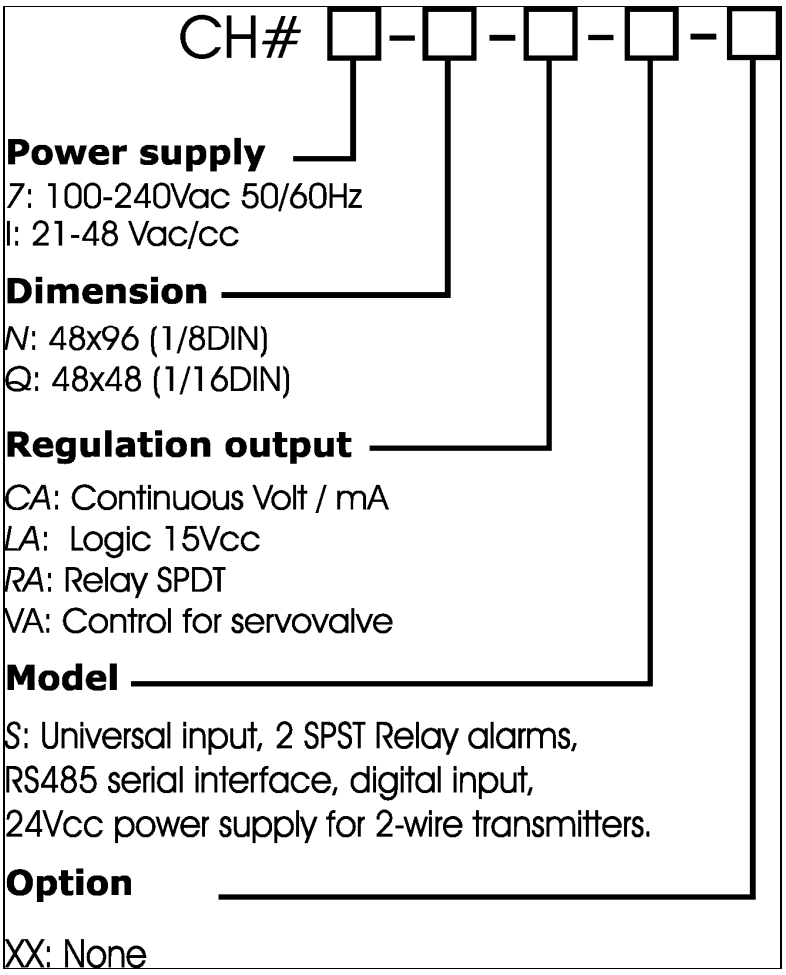
- **Do not rub not strike the display unit of this instrument with a hard object.**

This controller has been designed with compliance to 'Regulations on electrical apparatus (appliance, systems and installations) according to the European Community directive 73/23/EEC amended by the European Comunity directive 93/68/EEC and the Regulations on the essential protection requirements in electrical apparatus EN61010- 1 : 93 + A2:95.
It is important to understand that it's responsibility of the installer to ensure the compliance of the regulations on safety requirements and EMC.

The products meet the requirements for the European WEEE.

Note: **Information in this user's manual is subject to change without notice. No part of this pubblication my be reproduced, transmitted, transcribed or stored in a retrieval system, or translated into any language in any form by any means without the written permission of the Italcoppie sensori s.r.l.**

1 Ordering code

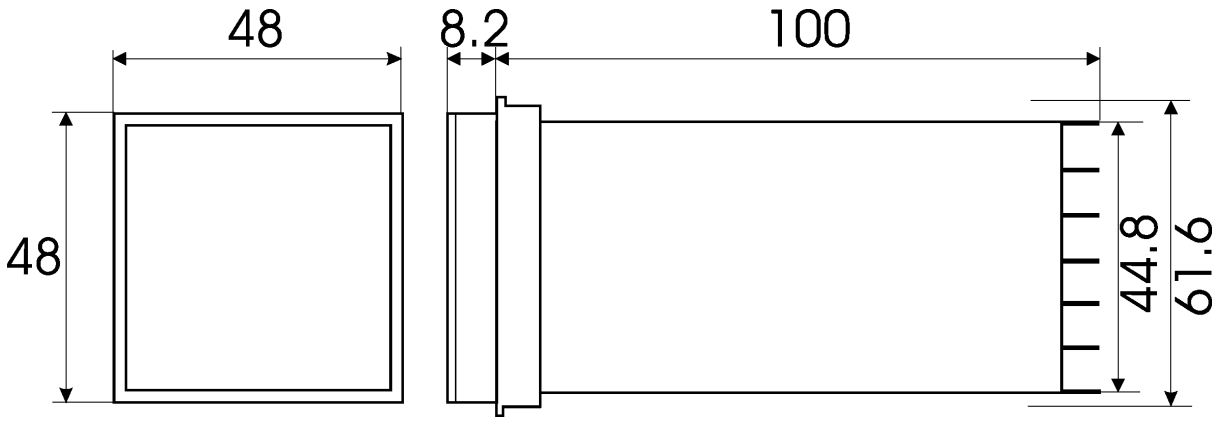


Note:
Universal input: **Thermocouple / Thermoresistence (Pt100 / Pt1000), Volt linear input (0-1/5 o 0-2/10 with an external adapter), mA linear input (0-4/20 with shunt external resistor).**
RS485 serial interface: **galvanic isolation, with Modbus RTU communication.**
Multi-function digital input: **galvanic isolation, enabled by an external contact like relay contact, switch, etc..**
Power supply for 2 wires transmitter: **24Vcc max. 25mA, with short circuit protection.**

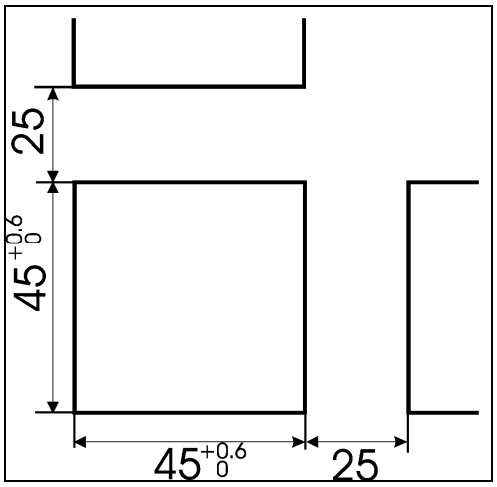
2 Installation

Installation must only be carried out by qualified personnel.
To prevent hands or metal touching parts that may be electrically live, the controllers must be installed in an enclosure and/or in a cubicle.

2.1 CH102 dimensions (measures on mm)

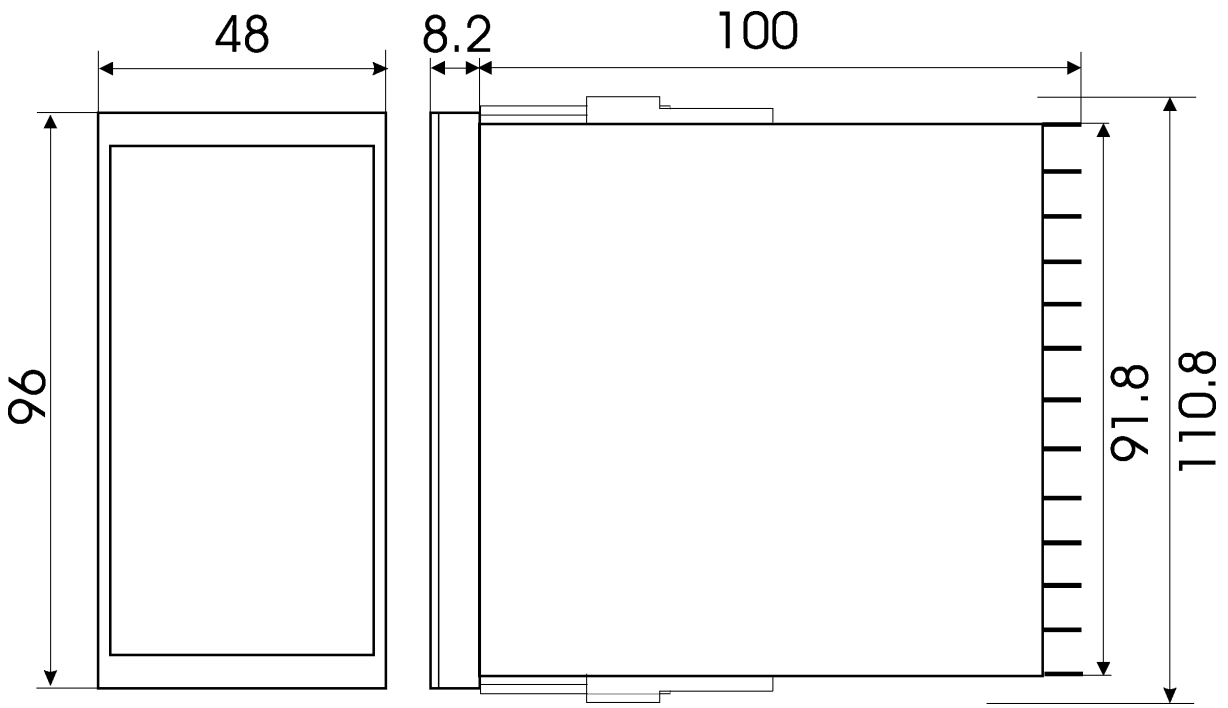


CH102 panel cut-out (measures on mm)

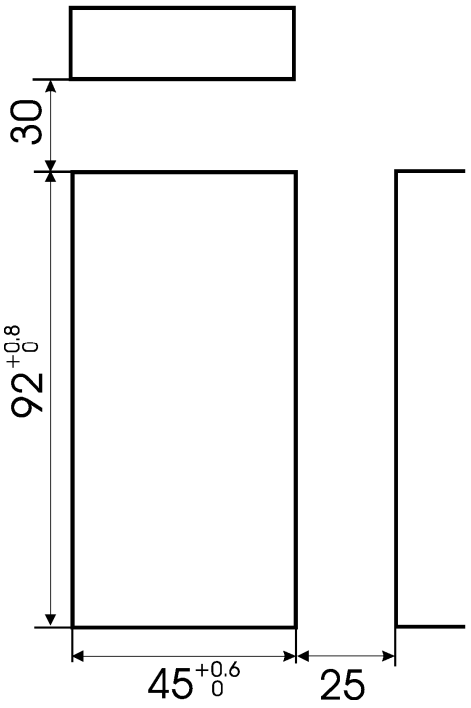


Note: The front of the instrument waterproof, conforms to IP65 with the instrument mounted on the control panel. In order to assure the waterproof, check that there is no dislocation of the packing nor clearance between the instrument and mounting frame with the instrument mounted.

2.2 CH402 dimensions (measures on mm)

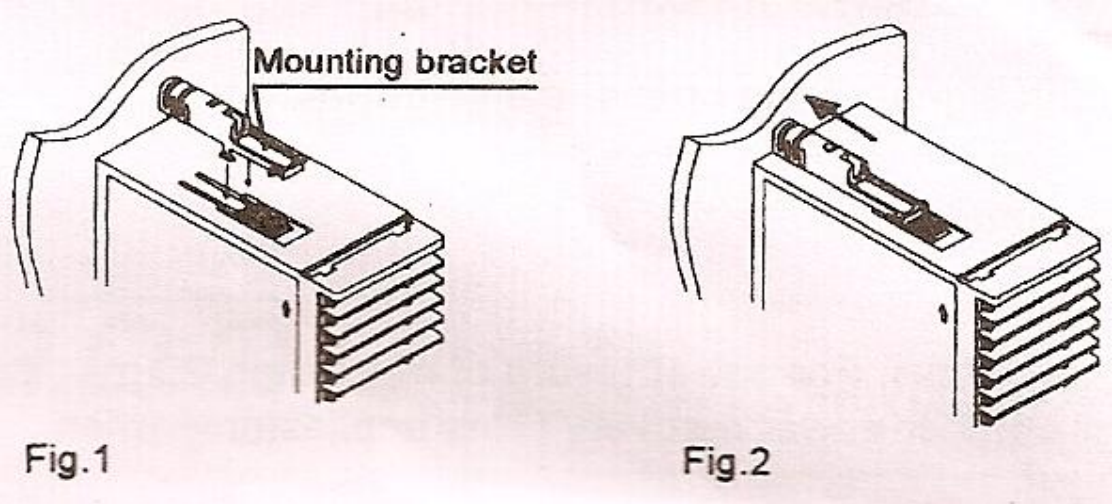


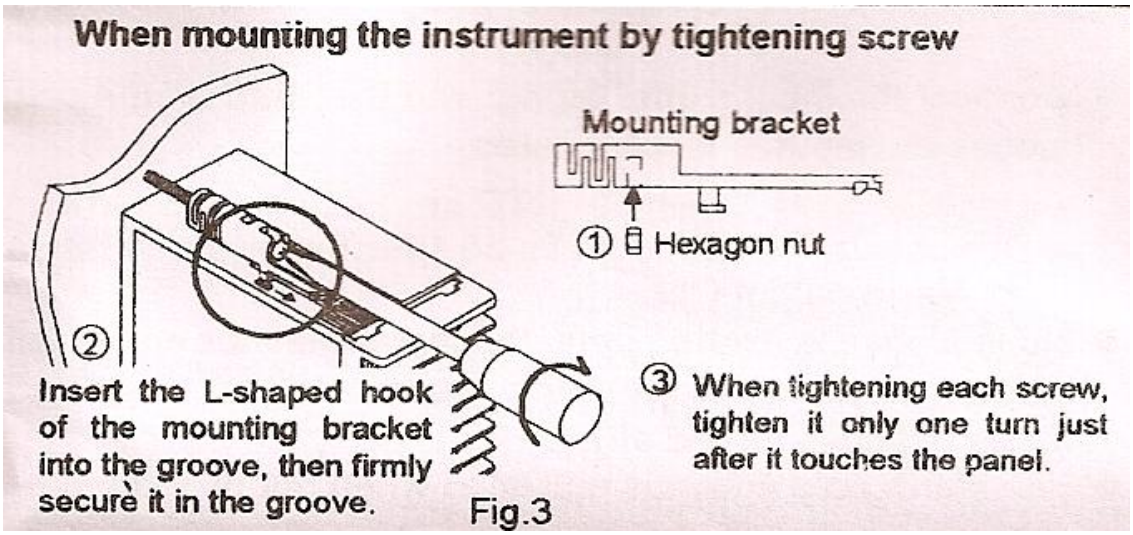
CH402 panel cut-out (measures on mm)



Note: The front of the instrument waterproof, conforms to IP65 with the instrument mounted on the control panel. In order to assure the waterproof, check that there is no dislocation of the packing nor clearance between the instrument and mounting frame with the instrument mounted.

2.3 Mounting procedures




When mounting the instrument by tightening screw
Mounting bracket
① Hexagon nut
②
Insert the L-shaped hook of the mounting bracket into the groove, then firmly secure it in the groove.
③ When tightening each screw, tighten it only one turn just after it touches the panel.
Fig.3

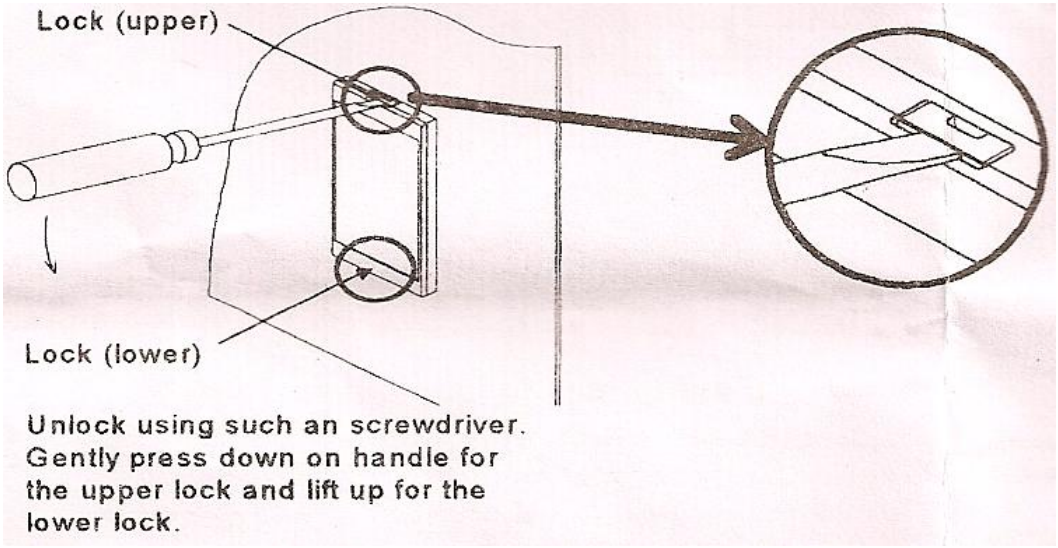
1) Make a rectangular/square holes corresponding to the number of instruments to be mounted through the panel by reffering to panel cutout dimensiions.
2) Insert the instrument into the panel from the panel cutout
3) Insert the mounting bracket into the mounting groove of the instrument (Fig.1)
4) Push the mounting bracket into the instrument until the instrument is firmly fixed to the panel (Fig. 2)

2.3 Instrument unplugging

-To prevent electric shock or instrument failure, only qualified personnel should be allowed to pull the internal assembly.

-To prevent electrical shock or instrument failure, always turn off the power before pulling out the internal assembly.
- Electrostatic discharges can damage the instrument; before removing the instrument from the shell, the operator must discarge himself to ground.
-To prevent injury or instrument failure, do not touch the insternal printed circuit board

2.3.1 How to pull out the internal assembly


Lock (upper)
Lock (lower)
Unlock using such an screwdriver.
Gently press down on handle for
the upper lock and lift up for the
lower lock.

CAUTION: Don't force to unlock to protect the frame against possible damage.
Note: Recommended tool: Minus-headed screwdriver (Recommended head widht:6mm)

3 Environmental ratings

Operating conditions	
Temperature	**0…50°C**
Relative humidity non-condensing	**45%…85%**

FORBIDDEN Conditions
Corrosive atmosphere
Explosive atmosphere

3.1 Mounting cautions

This instrument is intended to be used under the following environmental conditions: Overvoltage category II , Pollution degree 2.

Avoid the following when selecting the mounting location:

- **Ambient temperature of less than 0°C or more than 50°C**

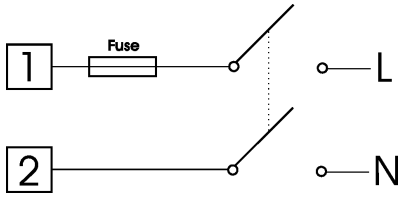
- **Ambient humidity of less than 45% or more than 85% RH**
- **Rapid change in ambient temperature wich may cause condensation**
- **Corrosive or inflammable gases**
- **Direct vibration or shock to the mainframe**
- **Water, oil, chemicals, vapor or steam splashes**
- **Excessive dust, salt or iron particles**
- **Excessive induction noise, static electricity, magnetic fileds or noise**
- **Direct airflow from an air conditioner**
- **Should be used indoord where the system is not exposed to direct sunlight**
- **Heat to be accumulated radiation heat.**

4 Wiring

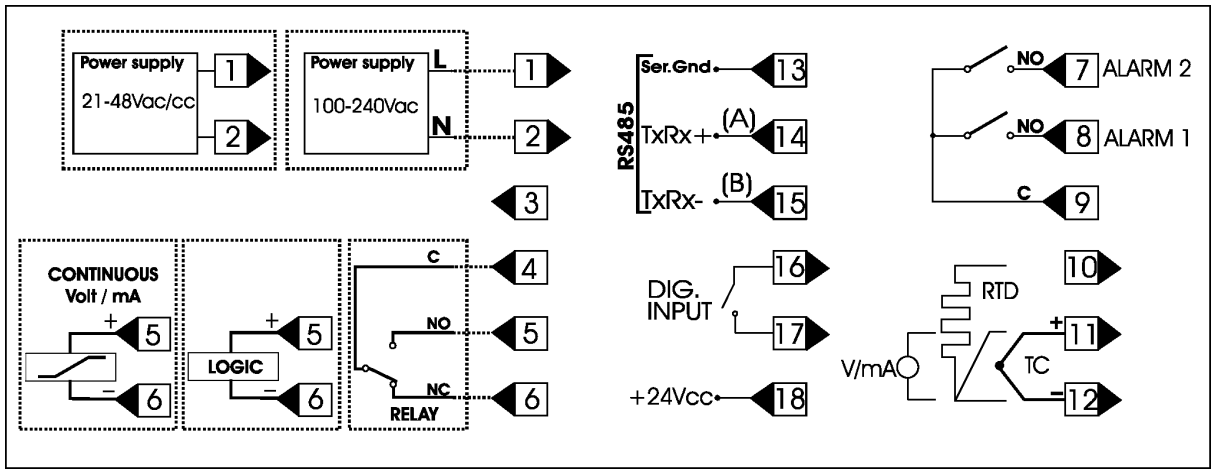
Despite the fact that the instrument has been designed to work in an harsh and noisy environmental, it is strongly recommended to follow the following suggestions.

All the wiring must comply with the local regulations.

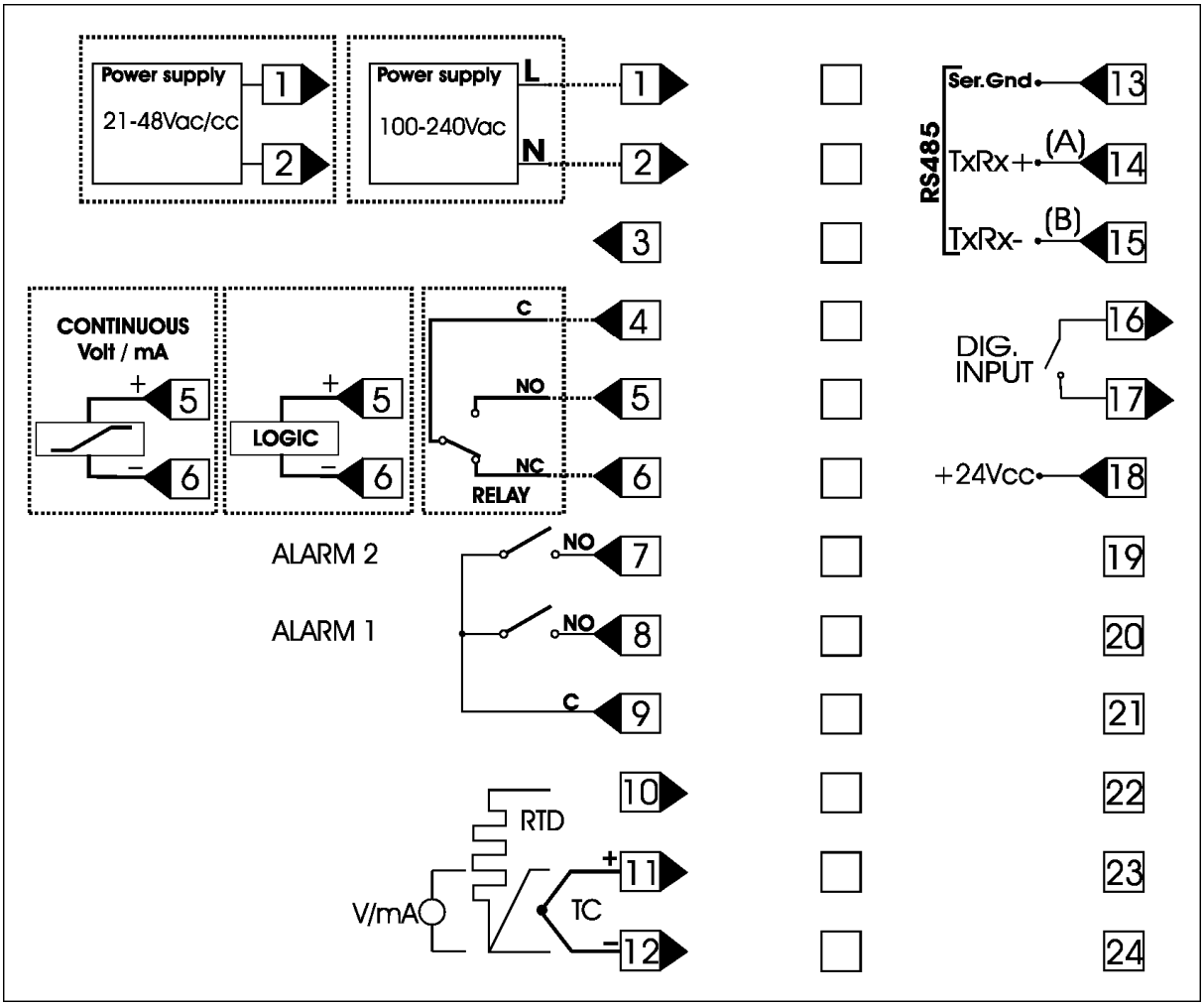
¤ The supply wiring should be routed away from the power cables.
¤ Avoid to use electromagnetic contactors, power relays and high power motors nearby.
¤ Avoid power units nearby, especially if controlled in phase angle
¤ Keep the low level sensor input wires away from the power lines and the output cables.
¤ If this is not achievable, use shielded cables on the sensor input, with the shield connected to earth.
¤ Make sure that the power supply voltage is the same indicated on the instrument.
¤ Switch on the power supply only after that all the electrical connections have been completed.
¤ Conduct instrument power wiring so as not to be influenced by noise from the electric equipment power. If the instrument may be affected by external noise, a noise filter should be used; install the noise filter on the panel wich is always grounded and minimize the wiring distance between the noise filter output side and the instrument power terminals.
¤ In accordance with the safety regulations, the power supply switch shall bring the identification of the relevant instrument. The power supply switch shall be easily accessible from the operator. To protect the instrument internal circuits use a 1 Amper 250V fuse:



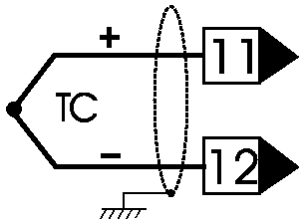
4.1 CH102 terminal configuration (MODEL S):



4.2 CH402 terminal configuration (MODEL S):

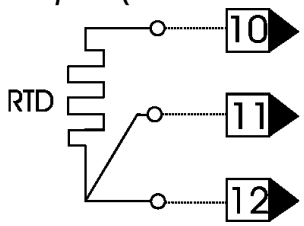


4.3 Thermocouple input



- **Connect the wires with the polarity as shown**
- **Use always compensation cable of the correct type for the therocouple used**
- **The shield, if present, must be connected to a proper earth**
- **See programmation instrument chapter to understand how to set the right type of thermocouple.**

4.4 Resistance termometer input (Pt100 IEC – Pt1000 IEC)



- **If a 3 wire system is used, use always cables of the same size (1mm² min.). Line 10Ω/lead maximum resistance.**
- **When using a 2 wires system, use always cables of the same size (1,5mm² min.) and put a jumper between terminals 11 and 12.**
- **Over terminals 10-11-12, can be plugged either PT100 or Pt1000 resistance termometer. The Pt100/Pt1000 selection have to be made by an internal jumper over instrument board, and by SL1 parameter setting.**

4.4.1 Input probe Setting Pt100 or Pt1000

CAUTION:

1) To prevent electric shock or instrument failure, only qualified personnel should be allowed to pull the internal assembly;to prevent electrical shock or instrument failure, always turn off the power before pulling out the internal assembly. Electrostatic discharges can damage the instrument; before removing the instrument from the shell, the operator must discarge himself to ground.
Pull out the internal assembly (please refer to chapter '*How to pull out the internal assembly*')
2) Set the jumper for Pt100 or Pt1000 accordling your sensor as following:

PT100 (Series CH102)

PT1000 (Series CH102)

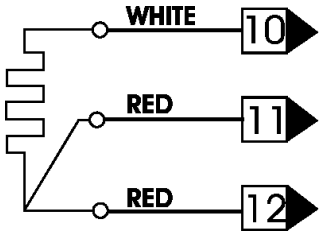
PT100 (Series CH402)

PT1000 (Series CH402)

ATTENTION: <u>The jumper factory default setting is Pt100</u>

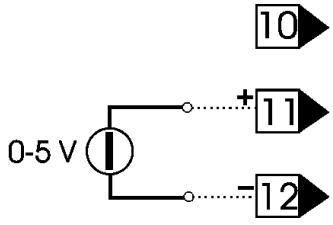
3) **Pull in the insternal assembly and power on the instrument.**
4) **On menù level 3 set the parameter SL1 = 1000 (Pt100/Pt1000). (Please see instrument programmation chapter for more infromations).**

4.4.2 Wiring RTD accordling IEC751



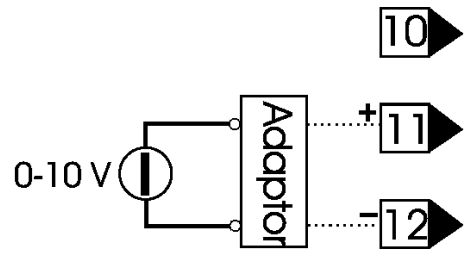
4.5 Linear input signals

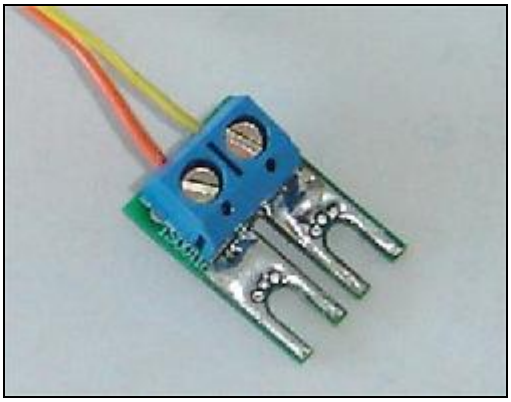
4.5.1 0-5 Volt or 1-5V signal input

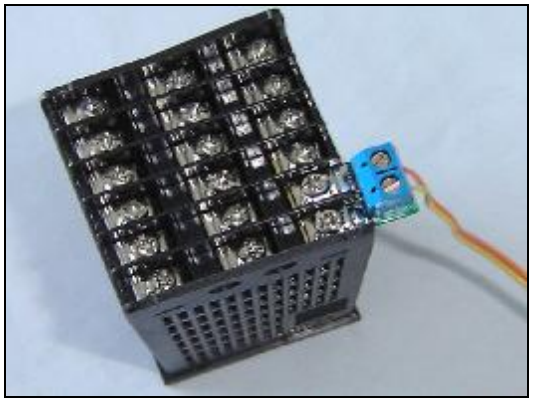


On level 3 menù, set SL1 = 1100 for the 0-5Volt input, or SL1 =1101 for 1-5Volt input.

4.5.2 0-10 Volt or 2-10V signal input

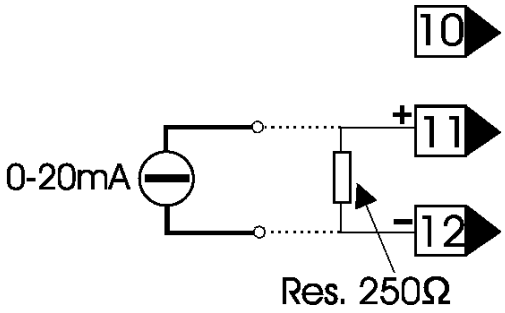






The above adaptor is enclosed with instrument packaging.
On level 3 menù, set SL1 = 1100 for the 0-10Volt input, or SL1 =1101 for 2-10Volt input.

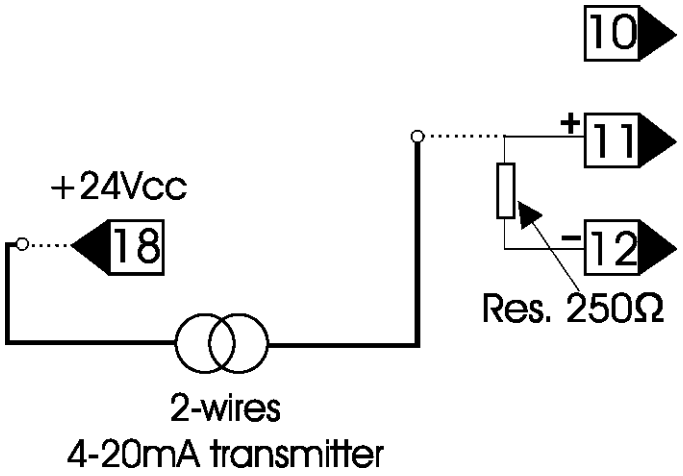
4.5.3 0-20mA or 4-20mA linear input



<u>ATTENTION</u>: for the 0/4-20mA linear input, put between the terminals 11 and 12 the 250 Ω shunt resistor enclosed on instrument packaging.

On level 3 menù, set SL1 = 1100 for the 0-20mA input, or SL1 =1101 for 4-20mA input.

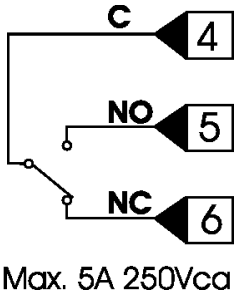
4.6 4-20mA linear input for 2 wires transmitters



On level 3 menù, set SL1 = 1101 for 4-20mA input sensor.

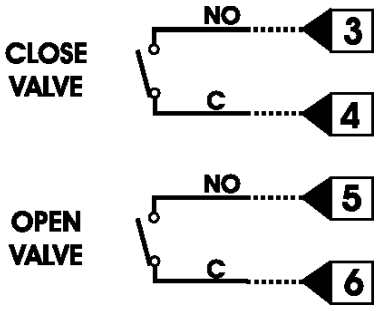
ATTENTION: The power supply for 2-wires transmitter is 24Vcc±15% max. 25mA. This power supply is short circuit protected.

4.7 Relay output



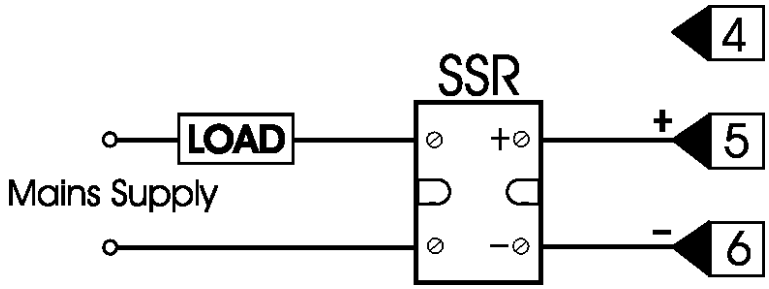
<u>Note</u>: to increase the relay life, it's well advised to set the parameter '*Cycle time*' higher than 10 seconds.
If you use a load higher than 5°, you must use an external relay.

4.8 Servovalve output



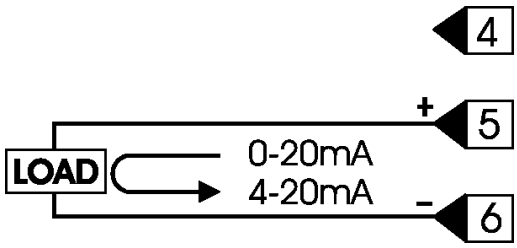
The 2 SPST relay are inter-blocked: only one relay a time will be active.
Maximum load for any relay: 3A @250Vac.
***Note*: The valve control will be available from next firmware version**

4.9 Logic output for static relay



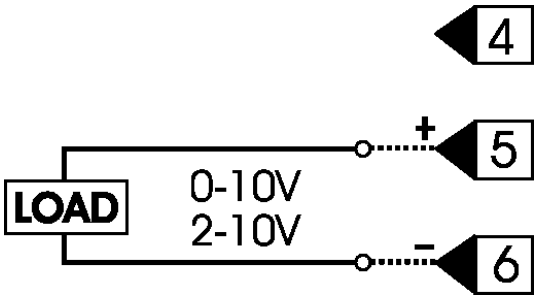
Output 15Vcc ±20% max. 35mA* for static relay command.
Note: to have a best regulation, it's well advised to set the parameter '*Cycle time*' like 1 second.
The Logic output (terminals 5 and 6) is shor circuit protected.
Note: for the hardware version 1_0 the maximum supply current is 12mA

4.10 mA continuous output



Maximum load: 500 Ω
Short circuit protected
The offset selection (0 or 4 / 20mA) have to be made by SL6 parameter on menù level 3.

4.11 Volt continuous output



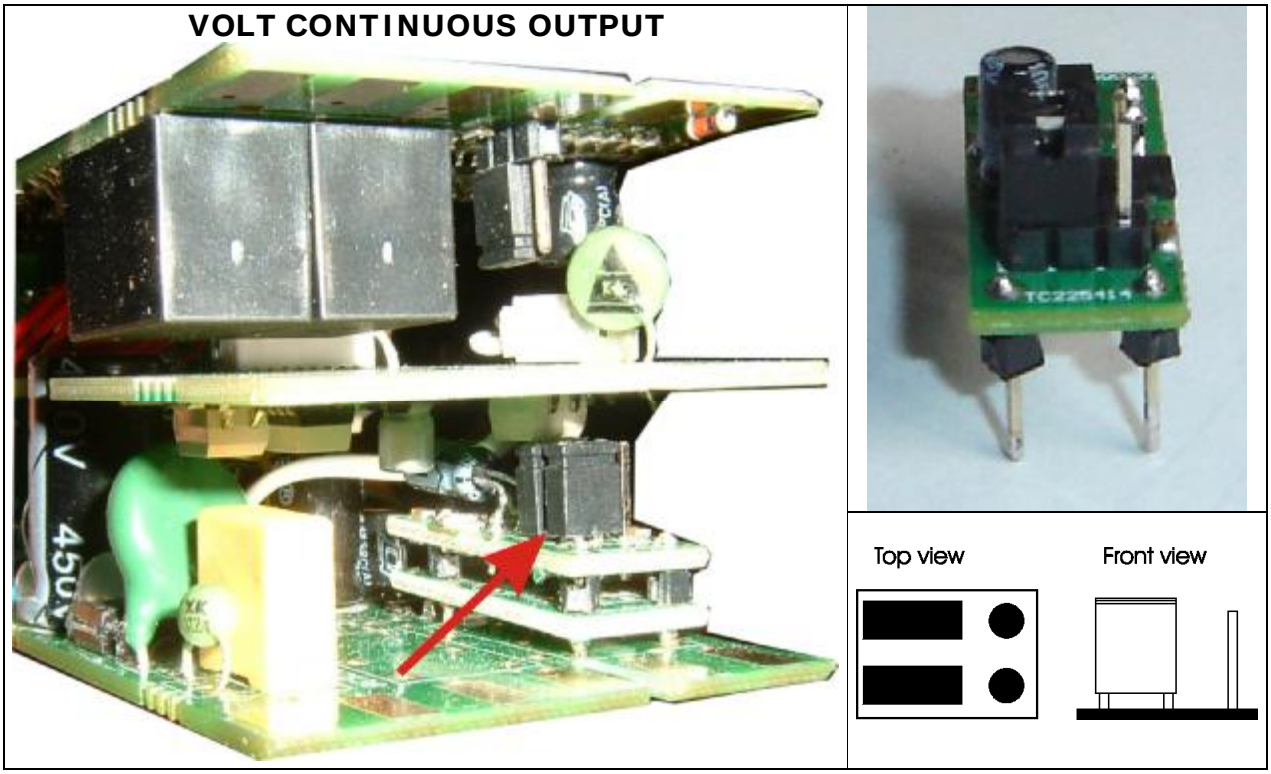
ATTENTION: Minimum load: 1KΩ (Max. current 10mA).
Short circuit protection
The offset selection (0 or 2 / 10V) have to be made by SL6 parameter on menù level 3.

4.12 Selection from Volt or mA continuous output

CAUTION:

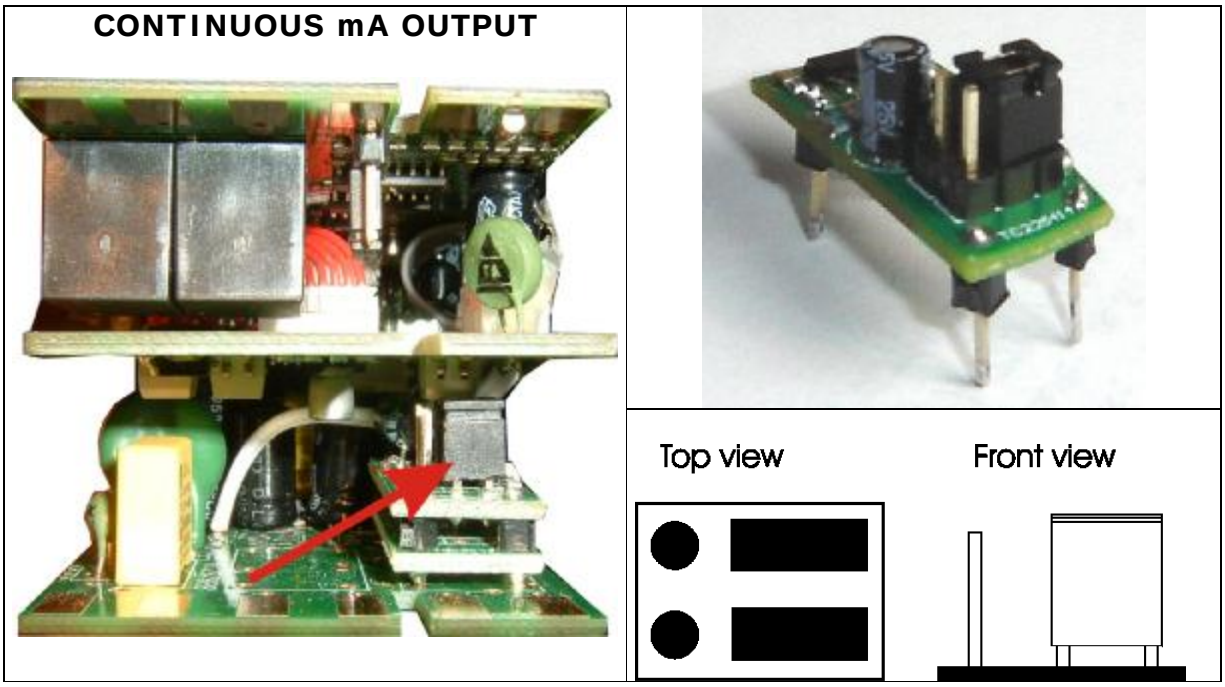
To prevent electric shock or instrument failure, only qualified personnel should be allowed to pull the internal assembly;to prevent electrical shock or instrument failure, always turn off the power before pulling out the internal assembly. Electrostatic discharges can damage the instrument; before removing the instrument from the shell, the operator must discarge himself to ground.
Pull out the internal assembly (please refer to chapter '*How to pull out the internal assembly*')

4.12.1 Jumper for Volt continuous output



For output offset selection (0-10V or 2-10V) set the SL6 parameter on menù Level 3 (see chapter 'Level 3 description parameters'**)**

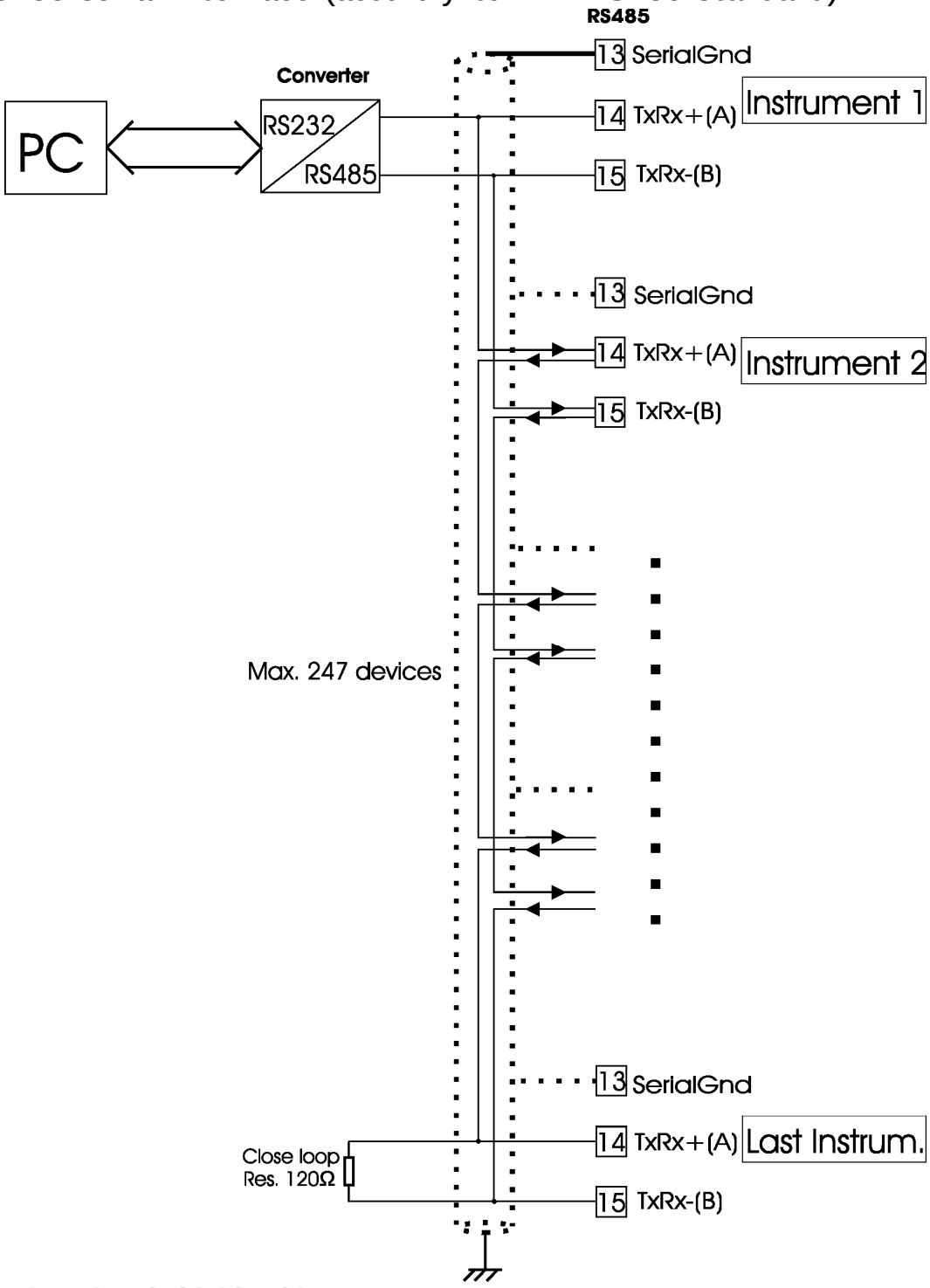
4.12.2 Jumper for mA continuous output



For output offset selection (0-20mA or 4-20mA) set the SL6 parameter on menù Level 3 (see chapter 'Level 3 description parameters'**)**

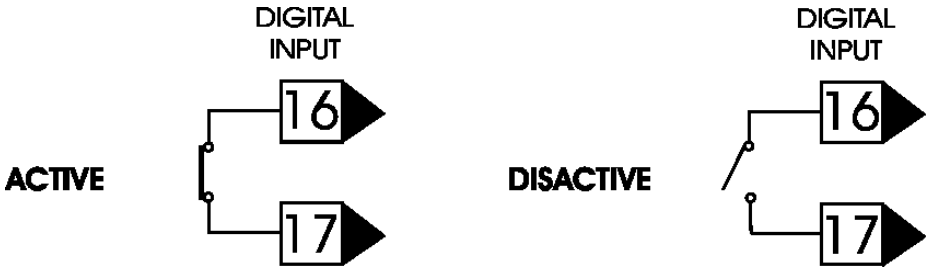
ATTENTION: The default factory setting is 4-20 mA ouput (only for instrument with continuous output)

5 RS485 serial interface (accordly to EIA RS485 standard)



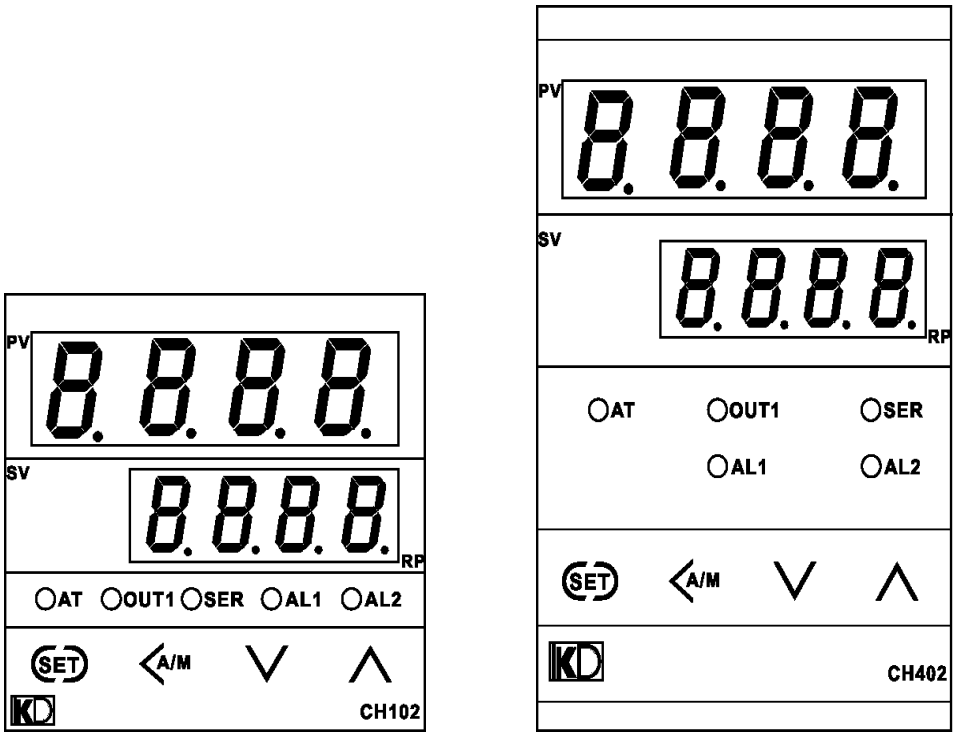
Use only twisted shield cable.
On last instrument network put a 120Ω resistor between the RS485 lines A and B (terminal 14 and 15)
To test the serial interface it's available the CH-SET kit (code SOFT002): the kint include a RS232/RS485 serial converter, and the Windows® software Conf-CH to see and set all instrument parameters (it is possible a free download of Conf-CH software from web site www.italcoppie.it)
The serial interface is galvanic isolated (2,5Kvolt).

6 Digital input



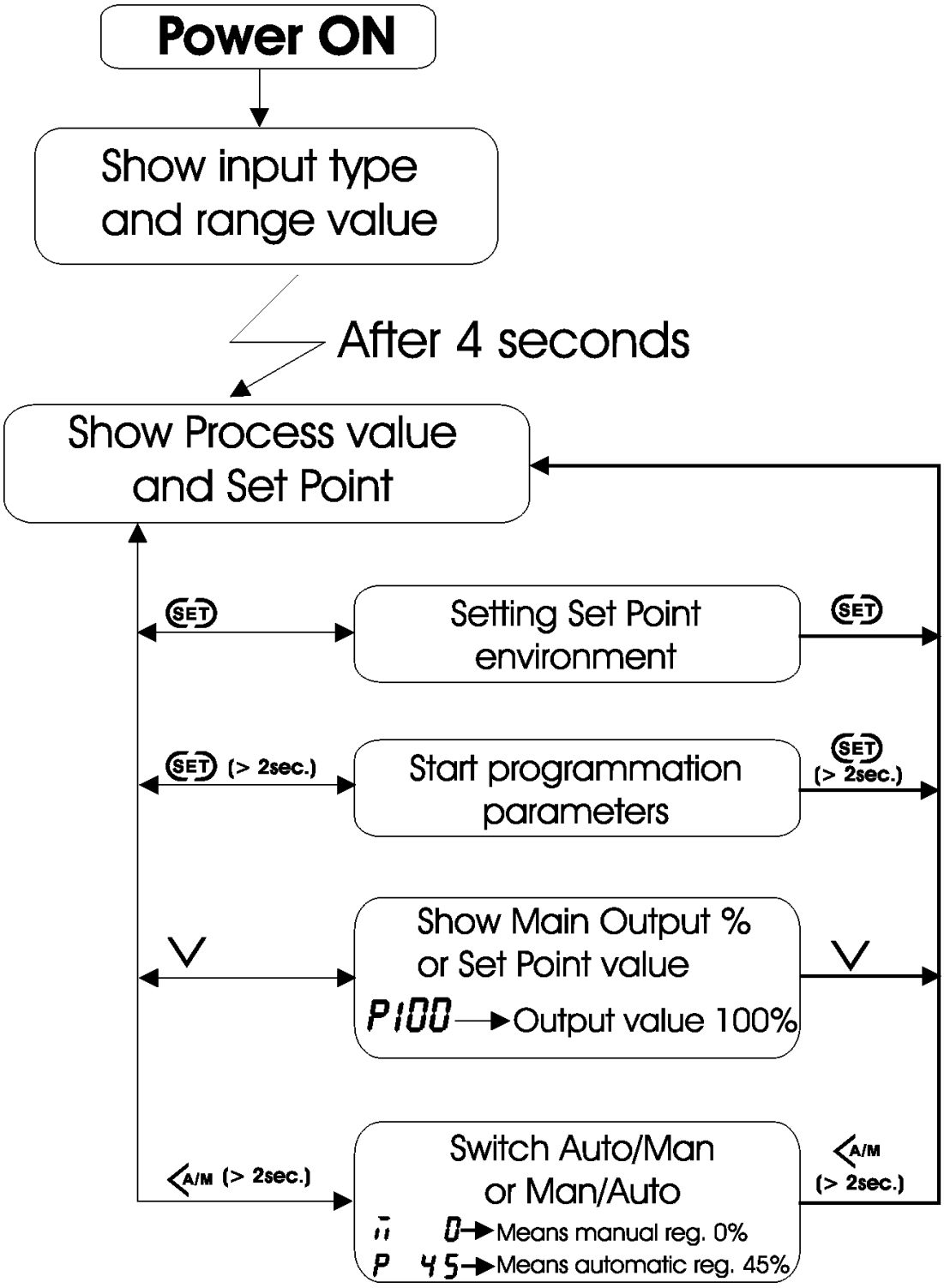
ATTENTION: The digital input is galvanic isolated. DON'T wire any supply at the terminal 16 and 17: this operation may broke the digital input. At the terminal 16 and 17, wire a free power contact like mechanical switch and relay contact. For all the digital input functions, see SLA parameter on menù Level 3.

8 Front panel description



PV	***Green display*: Process Value**
SV	***Orange display*: Setting value or Main regulation Output %**
OUT1	***Green Led*: Main regulation Output status**
AL1	***Red Led*: Alarm 1 status**
AL2	***Red Led*: Alarm 2 status**
AT	***Orange Led*: autotuning status (blinking when active)**
SER	***Green led*: serial communicatzion (blinking when active)**
RP	***Decimal point*: Set point ramp (blinking when active)**
SET	***Key*: Store parameter or change mode**
A/M	***Key*: switch Auto/Man or shift digit on setting parameter**
	***Keys*: changing parameter value**

9 Operating environment



If any keys are pressed for a time higher 1 minuts, the display automaticly will show the process value (PV) on upper display, and the Set point (SV) on down display.

9.1 Input type and input range display

At the power the display instrument will show the input type the range and the measuring unit.
Example: for a controller with the K thermocouple input type and range from 0 to 1372°C:

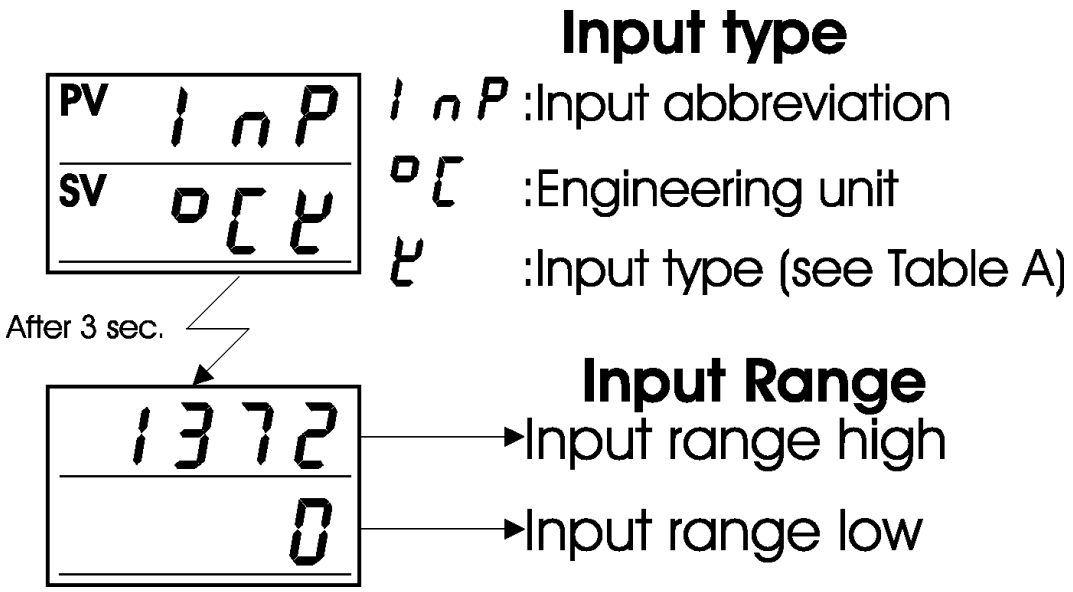


Table A

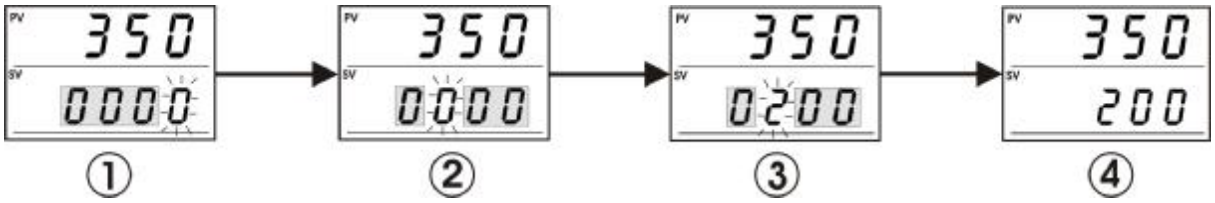
Display	tJ	r	S	b	E	t	n	Cu	Pt	u	
Input type	Thermocouple							RTD			
	K	J	R	S	B	E	T	N	Pt100* Pt1000	0-20mA	0-5Volt* 0-10Volt

*** For Pt100/Pt1000 or 0-5V / 0-10V selection see chapter 'Wiring'.**

9.2 Parameter setting procedure

Setting Set Value (SV).

Example: following is an example of set value (SV) to 200°C:



Step by step:

1) **Press SET key to enter the SV setting mode. The digit wich light brightly is settable.**
2) **Press the <A/M key to shift the digit wich light brightly up to the hundreds digit.**
3) **Press the UP key to set "2". Pressing the UP key increase numerals, and pressing the DOWN key decrease numerals.**
4) **After finishing the setting, press the SET key. All of the set value digits light brightly and as a result the instrument returns to the PS/SV display mode.**

Setting parameters other than set value (SV)
L'impostazione dei parametri di programmazione deve essere eseguita nella stessa modalità sopra riportata, seguendo i passi da 1 a 4.

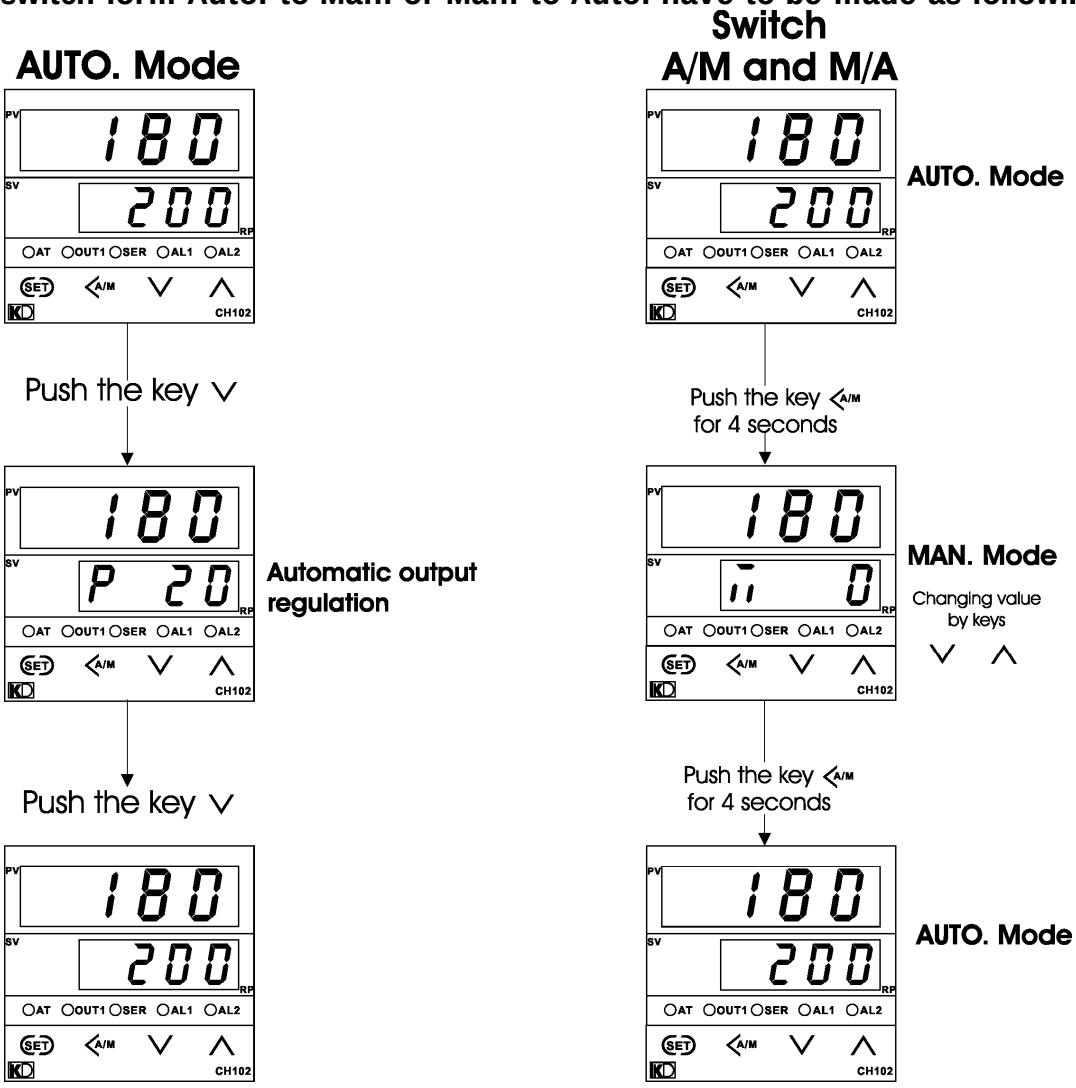
The setting procedure are the same as those of example (2) to (4) in the above "Setting set value (SV)". Pressing the SET key after the setting end shifts to the next parameter. When no parameter setting is required, return the instrument to the PV/SV display mode.

Key operational cautions:

- **Even if the displayed value is changed, it is not registred. To register it, press the SET key.**
- **If the key is not operated for more than 1 minute, the present mode return to the PV/SV display mode.**

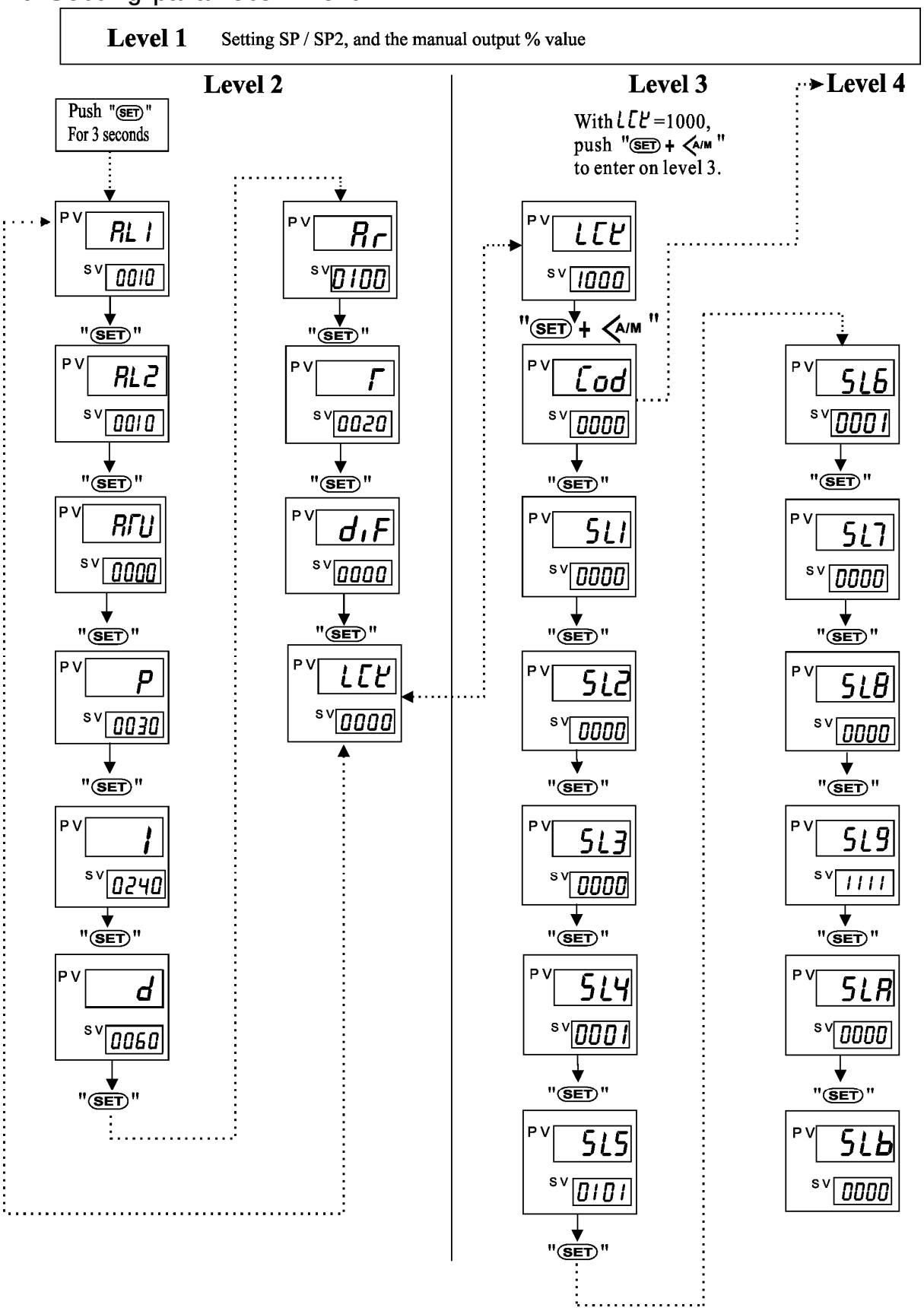
9.3 AUTO/MAN and MAN/AUTO REGULATION SWITCH

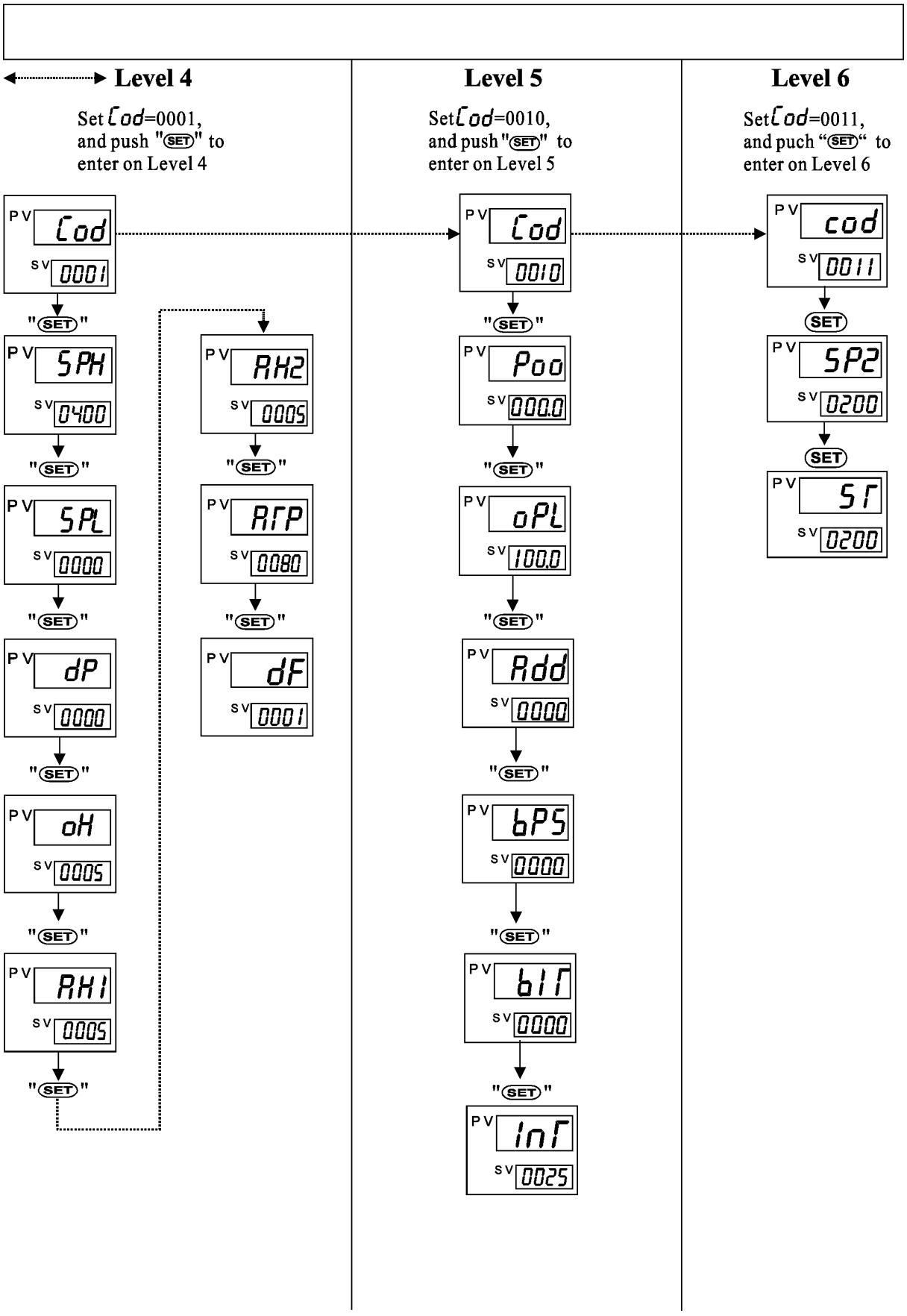
If SL8 parameter (menù level 3) is enabled (xx1x), the instrument can run either on manual mode (the user make themself a manual regulation setting the main regulation output) or in automatic mode (the instrument calculate automaticly the right regulation output to achieve the Setting value)
The switch form Auto. to Man. or Man. to Auto. have to be made as following:



For safety, any time the user switch from Automatic to Manual regulation, automaticly the regulation output will be set to 0 % (OFF).
Next, by UP / DOWN keys will be possible set the desired vaule: the output actuation will be immediate, without the SET key confirmation.
Note: It's not possible the AUTO/MAN switch by '<M/A' key if the same function is enabled on digital input function (Parameter *SLA = 0010* on menù level 3).

10 Setting parameter Menù


Level 1
Setting SP / SP2, and the manual output % value
Level 2
Level 3
Level 4
Push "SET" For 3 seconds
With LCK=1000, push "SET + A/M" to enter on level 3.
"SET + A/M"
PV AL1 SV 0010
PV AL2 SV 0010
PV AMU SV 0000
PV P SV 0030
PV I SV 0240
PV d SV 0060
PV Ar SV 0100
PV r SV 0020
PV diF SV 0000
PV LCK SV 0000
PV LCK SV 1000
PV Cod SV 0000
PV SL1 SV 0000
PV SL2 SV 0000
PV SL3 SV 0000
PV SL4 SV 0001
PV SL5 SV 0101
PV SL6 SV 0001
PV SL7 SV 0000
PV SL8 SV 0000
PV SL9 SV 1111
PV SLA SV 0000
PV SLb SV 0000
"SET"


Level 4
Level 5
Level 6
Set Cod=0001, and push "SET" to enter on Level 4
Set Cod=0010, and push "SET" to enter on Level 5
Set Cod=0011, and puch "SET" to enter on Level 6
PV Cod SV 0001
"SET"
PV SPH SV 0400
"SET"
PV SPL SV 0000
"SET"
PV dP SV 0000
"SET"
PV oH SV 0005
"SET"
PV RH1 SV 0005
"SET"
PV RH2 SV 0005
"SET"
PV RTP SV 0080
"SET"
PV dF SV 0001
PV Cod SV 0010
"SET"
PV Poo SV 000.0
"SET"
PV oPL SV 100.0
"SET"
PV Rdd SV 0000
"SET"
PV bPS SV 0000
"SET"
PV bIT SV 0000
"SET"
PV InT SV 0025
PV cod SV 0011
SET
PV SP2 SV 0200
SET
PV ST SV 0200

11 Programmation parameters table

LEVEL 2 MENU' *Access: Push the SET key for 3 seconds*			
Display	***Description***	***Setting range***	***Default value***
AL1 **Add:5**	**AL1 Threshold**	**SPH-SPL**	**10°C**
AL2 **Add:6**	**AL2 Threshold**	**SPH-SPL**	**10°C**
AtU **Add:7**	**Auto Tuning**	**0:Disabled** **1:Enabled**	**0** Disabled
P **Add:8**	**Proportional Band**	**0: ON-OFF Regulation** **SPH-SPL**	**30°C**
I **Add:9**	**Integral Time**	**0:Integral time exclusion** **1-3600 seconds**	**240 seconds**
d **Add:10**	**Derivative time**	**0:Derivative time exclusion** **1-3600 seconds**	**60 seconds**
Ar **Add:11**	**Integral time limitation**	**100%: No limitation** **1-99%**	**100%**
t **Add:12**	**Cycle time**	**1-100 seconds**	**1 sec. (Logic Out.)** **20 sec. (Relay Out.)**
diF **Add:16**	**Offset PV**	**-1999/+1999**	**0°**
LCY **Add:17**	**Lock Function**	**See Table B**	**-**
Cod **Add:18**	**Lock code**	**See Setting parameter menù**	**-**

LIVEL 3 MENU' *Access:from Livel 2, set Lock =* 1000 *and* Cod = 0000 *then push SET + <A/M keys togheter*				
Display	***Description***	***Setting Range***		***Default value***
SLI	**Input sensor selection**	**0000**	**K**	**0001** **Thermocouple j** ***See Note 1***
		0001	**J**	
		0010	**E**	
		0011	**N**	
		0100	**R**	**Note:** *The 0-10V or 2-10V input, need the enclosed adaptor. (see chapter 'wiring'). **For current input signal,
		0101	**S**	
		0110	**B**	
		0111	**T**	
		1000	**Pt100/Pt1000**	

		1001	**Cu50**	connect the enclosed 500Ω shunt resistor (see chapter 'wirement')
		1010	**0-5V***	
		1011	**1-5V***	
		1100	**0-20mA****	
Add:19		**1101**	**4-20mA****	
SL2	**Unit of Temperature**	**xxx0** **°C** **xxx1** **°F**		**0000 (°C)**
Add:20				
SL3	**Reserved**	**-**		**-**
SL4	**Alarm 1 setting**	**x000**	**Disabled**	**0001** Deviation high Without suppressing alarm at the power on
		x001	**Deviation high**	
		x010	**Deviation high/low**	
		x011	**Process high**	
		x101	**Deviation low**	
		x110	**Band**	
		x111	**Process low**	
		0xxx	**Without suppressing**	
Add:22		**1xxx**	**With suppressing**	
SL5	**Alarm 2 setting**	**x000**	**Disabled**	**0101** Deviation low Without suppressing alarm at the power on
		x001	**Deviation high**	
		x010	**Deviation high/low**	
		x011	**Process high**	
		x101	**Deviation low**	
		x110	**Band**	
		x111	**Process low**	
		0xxx	**Without suppressing**	
Add:23		**1xxx**	**With suppressing**	
SL6	**Action and offset selection (the last one only for continuous output)**	**xxx0** **xxx1**	**Direct action** **Reverse action**	**0101:** for instruments with continuous output **0001:** For instruments with Relay or logic output
		X0xx	**Relay or Logic output**	
		x11x **x10x**	**0-20mA | 0-10V output** **4-20mA | 2-10V output**	
Add:24				
SL7	**Alarm relay trigger type**	**xxx0** **xxx1**	**Trigger NO à NC** **Trigger NC à NO**	**AL1** **0000** AL1:Trigger No **à** Nc AL2:Trigger No **à** Nc
		xx0x **xx1x**	**Trigger NO à NC** **Trigger NC à NO**	**AL2**
Add:25				
SL8	**Power on manual out.**	**0xxx** **1xxx**	**Man. out = 0%** **Last man. out set**	**0110** Man. Power on = 0% Regulation Auto/Man Serial interface enabled
	Regulation Selection	**xx0x** **xx1x**	**Automatic Reg.** **Selection Auto/Man**	

Add:26	**Serial interface**	**x0xx** **x1xx**	**Disabled** **Enabled**	
SL9	**Reserved**	***Don't change the default value***		**1111**
SLA	**Digital input**	**0000**	**No function**	**0000** No function
		0001	**Switch from SP<->SP2**	
		0010	**Swithc from AUTO<->MAN**	
Add:28		**0011**	**Keyboard lock**	
SLb	**Set point ramp**	**1xxx** **0xxx**	**Ramp enabled** **Ramp disabled**	**0000** Disabled
Add:29				

LEVEL 4 MENU'

Access: from Level 2, set Lock = 1000 and
Cod = 0001 then push the SET key

Display	*Description*	*Setting Range*	*Default value*
SPH	**Set Point High limit setting***	**See Table C** ***High linearization value for linear input Volt/mA**	**1200°C** ***See Note 1***
Add:30			
SPL	**Set Point Low limit setting***	**See Table C** *** Low linearization value for linear input Volt/mA**	**0**
Add:31			
dP	**Decimal point**	**0-3**	**0** No decimal point
Add:32			
oH	**On-OFF control Hysteresis**	**0-100.0**	**1.0°C**
Add:33			
AH1	**Alarm 1 Hystersis**	**0-100.0**	**1.0°C**
Add:34			
AH2	**Alarm 2 Hystersis**	**0-100.0**	**1.0°C**
Add:35			
ATP	**% Autotuning Set point**	**0-100%**	**80%**
Add:36			
dF	**Filter**	**0:Disabled** **1:Enabled**	**1** Filter enabled
Add:37			

MENU' LEVEL 5

Access: from Level 2, set Lock = 1000 and
Cod = 0010 then push the SET key

Display	*Description*	*Setting range*	*Default value*
Poo Add:38	Output Offset	0.0-100.0%	0.0%
oPL Add:39	Regulation output power limit	0.0 – 100.0%	100.0%
Add	Serial address	0: Disabled 1-255	1
bPS	Baud rate	0: 2400bps 1: 4800bps 2: 9600bps 3: 19200bps	2 9600bps
bIT	Communication parameters	Code / Bit / Parity / Stop bit 0 / 8 / None / 1 1 / 8 / odd / 1 2 / 8 / Even / 1	0000 No parity:N-8-1
Int	Modbus delay	0-2000mS	0mS

LEVEL 6 MENU'

Access: from Level 2, set Lock = 1000 *and*

Cod=0011 *then push the SET key*

Display	*Description*	*Setting range*	*Default value*
SP2 Add:2	Second Set Point	SPH-SPL	20°C
St Add:40	Set point ramp time	1-900 minutes	1 minute

Note 1: for the software version 1_1 the default sensor is thermocouple K and the set point limit is 1372°C.

Input probes range

Input probe	Range	Range SPL	Range SPH
K	0÷1372°C	0°C	1372°C
J	0÷1200°C	0°C	1200°C
R*	0÷1769°C	0°C	1769°C
S*	0÷1769°C	0°C	1769°C
B*	0÷1820°C	400°C	1820°C
E	0÷1000°C	0°C	1000°C
N	0÷1300°C	0°C	1300°C
T	0.0÷400.0°C	0.0°C	400.0°C
Pt100/Pt1000	-199.9÷649.0°C	-199.9°C	649.0°C
0/4-20mA	-1999÷+1999	-1999 u.i.	+1999 u.i.
0/1-5V 0/2-10V	-1999÷+1999	-1999 u.i.	+1999 u.i.

Table C

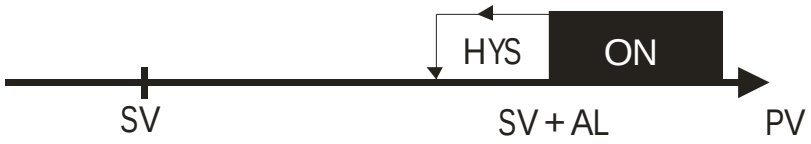
***Input accuracy is not guarantee from 0 to 399°C.**

11.1 Alarms description

The following graphical representations are referred to SL7 parameter = xx00 NO à NC. For more information over SL7 parameter, see next chapter.

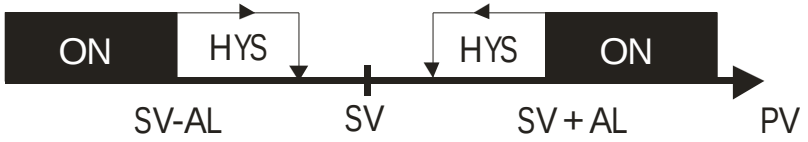
SV:Set Point value
AL: Threshold Alarm (AL1 / AL2)
PV: Process value

DEVIATION HIGH (code x001):



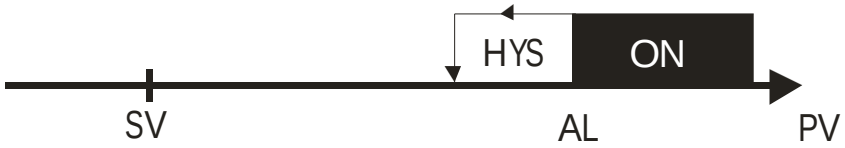
DEVIATION LOW (code x101):

DEVIATION HIGH/LOW (code x010):



BAND (code x110):

PROCESS HIGH (code x011):



PROCESS LOW (code x111):

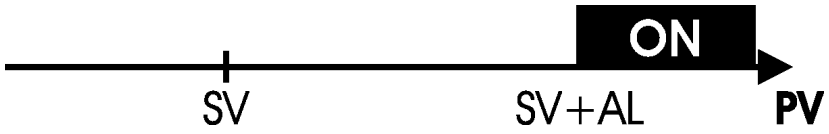
The black 'ON' area indicate the relay status alarm: ON = Relay contact closed.

11.2 Alarm trigger

SL7: Alarm relay trigger type

Example with Alarm 1 as deviation high:

If SL7 = xxx0 so the trigger is NO à NC (black area ON: realy closed contact):



If SL7 = xxx1 so the trigger is NC à NO (black area ON: realy closed contact):

11.3 Alarm Hysteresis

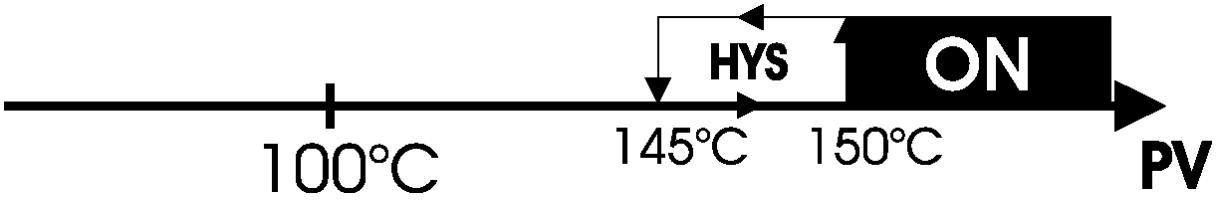
On menù Level 4, it is possible set the alarms Hysteresis by AH1 and AH2 parameters.

AH1: Alarm 1 hysteresis (for thermocouple and RTD sensor this value it's always on tenth of degree)

AH2: Alarm 2 hysteresis (for thermocouple and RTD sensor this value it's always on tenth of degree)

Hysteresis example over Alarm 1:

AL1 = 50°C
AH1 = 5.0°C
SL4 = 001 (deviation high)
SV = 100°C



11.4 Alarm suppressing at power on

The 'alarm suppressing at power on' function can be enabled by setting the most significant bit of SL4 parameter for Alarm 1 (SL4 = 1xxx) and SL5 parameter for alarm 2 (SL5 = 1xxx).
This function suppress the alarm at the power on ; instrument alarm often occurs immediatly after power on or set point change. Take electrical furnace temperature control (heating control) as an example;the actual temperature is far below target set point at power on. If lower alarm is configured, then the alarm condition may satisfied at power on; but in fact the control system my not have problem. If an alarm condition is satisfied again after it is cleared, then the alarm function is started up.
The alarm suppressing will start at the instrument power on and also at any Set point (SV) changing.

11.5 Level 2 parameters description

AL1: Alarm 1 threshold
AL2: Alarm 2 threshold

For alarms functionality see chapter 'Alarms description'

ATU: Auto-tuning
1: Auto-tuning enabled (orange AT led blinking)
0: Auto-tuning disabled (orange AT led off)

The autotuning functionality check the process and automaicly calculate the main P.I.D. paramaters (proportional band, integral time, derivative time) to achieve the best regulation without over or undershoot.
The autotuning can <u>NOT</u> be activated on the following situations:

- **The input sensor is under or over range;**
- **The input sensor is broke**
- **The instrument is on Manual regulation**

The autotuning <u>STOP</u> at the following situations:

- **If input sensor broke or go under or over-range**
- **The user change the regulation from automatic to manual**
- **The user change Set point (including the situation 'switch Set Point' from digital input)**
- **The user set the proportional band = = 0 (ON-OFF control).**

The autotuning is made by an ON-OFF control over a % set point defined on a ATP parameter (menù Level 4).

If AtP = 100% then the tuning will be made over the same Set point showed on instrument orange display: on the other case, (when Atp < 100%) the tuning Set point will be automaticly calculated with % of Atp parameter.

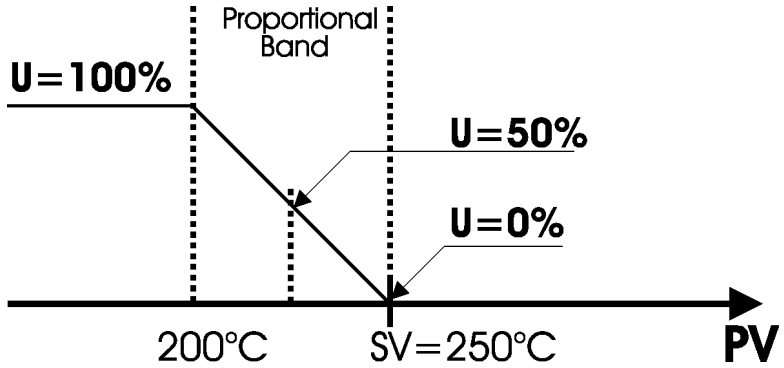
Example: If Set point = 150°C and the AtP = 80%, then the tuning will be made over Set Point = 120°C.

The tuning will check the process by an ON-OFF regulation: over this step,a big dangerous overshoot should be reach: so, before start the autotuning procedure, set the AtP parameter accordly to your system requred. At the end of autotuning process, the instrument will calculate the main PID parameters and il will start to regulate with right Set Point (with reference to above example, the autotuning will be made over SP=120°C, but at the end of autotuning procedure the regulation will be made automaticly to SP = 150°C with new PID calculated parameters).

P: Proportional band (on°C or °F or engineering units).

Is the action wich the control output varies in proportion to the deviation between the setting vale (SV) and the processing temperature (PV).

Example: P = 50°C, SV = 250°C. The proportional band could be draw as following:



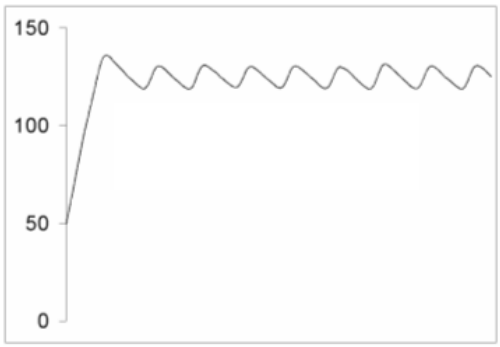
I the proportional band is narrowed, even if the output changes by a slight variation of the processing temperature, better control results can be obtained as the offset decreases.

However, if the proportional band is narrowed too much, even slight disturbances my cause variation in the processing temperature, control action changes to ON/OFF action and so hunting phenomenon occurs.

11.6 ON-OFF regulation

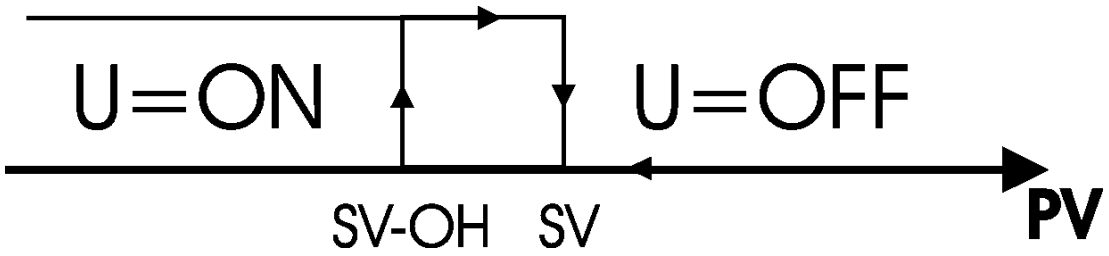
If the proportional band = 0, then the kind of control is ON-OFF.

When the controller is configured to work in ON / OFF mode, the output of the controller only takes two values, 0% or 100%. For example, in a temperature control process, the output takes the value of 100% when the process is under the setpoint and 0% when the process is above the consignment. The following graph shows the "saw tooth" shape with which the process reacts under this kind of control.

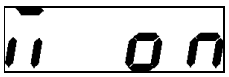


In this control mode, the user may programme a hysteresis between the connections and the disconnections

oH: ON-OFF Hysteresis (menù level 4) (for thermocouple and RTD sensors this value is on tenth/degree)



If the instrument work on manual mode, the user can set only 2 values ON (permanent output) and OFF (no output). The lower display will show:



Output ON

Output OFF

I: Integral time (0-3600 seconds)
Integral action is used to eliminate offset. When the integral time is short, the returning speed to the setting point is accelerated; however, the cycle of oscillation is also accelerated and the control becomes unstable.
It is possible exclude the integral time by setting the value = 0.

d: Derivative time (0-3600 seconds)
Derivative action is used to restore the change in the processing temperature according to the rate of change. It reduces the amplitude of overshoot and undershoot widht.
If the derivative time is shortened, restoring value becomes small, and if the derivative time is made longer, an excessive returning phenomenon my occur and the control system my be oscilleted.

Ar: Integral time limitation
This parameter can limitate the integral action. If = 100% NO integral time limitation occour.

IMPORTANT: Generally, a proportion must be maintained between integral time(Ti) and derivative time (Td) so that Td takes the value of a quarter of the value of Ti. In other words. Td = Ti / 4 (example: Ti=240, Td=60).
Therefore, the controller output will vary between 0% and 100% as a result of the sum of the Proportional, Integral and Derivative actions.

r: Cycle time (1-100 seconds)
A controller with a modulated output doses the amount of power supplied to the process between 0% and 100%. As a modulated output there might be:

Output modulated by pulses: **When it is a question of dosing the power supplied to the process with a device such as a relay or a solid status relay, it is achieved by varying a connection time on a fixed cycle which in the controller is configured by this parameter r.**

For example, with a 30-second output cycle, the power delivered to the process can be dosed between 0% and 100% in fractions of 0.3 seconds (30 sec. / 100). See the following table supposing a cycle of 30 seconds:

To give the process...	the output must be active for ...	... and deactivated for ...	Total cycle (seconds)
...10% power	3 seconds	27 seconds	3+27=30"
... 25% power	7.5 seconds	22.5 seconds	7,5+22,5=30"
... 50% power	15 seconds	15 seconds	15+15=30"
... 80% power	24 seconds	6 seconds	24+6=30"
... 100% power	30 seconds (there is no disconnection of the output)	0 seconds	30+0=30"

This means that every 30 seconds the controller activates the output, but depending on the percentage that it should deliver to the process, it will take more or less time to carry out the disconnection.

The cycle time it's a valid parameter only for the relay or logic output; for relay output we suggest to set values high than 20 seconds (to increase the contact relay life); for logic output, we suggest to set this parameter = 1 seconds to achieve best regulation.

dIF: Deviation of the indication with respect to the read value of the variable. For instance, if the instrument takes a reading of 200 and dIF = 20, the value of the measurement will be 220 (200 + 20).

LCK	Details of lock levels
0000	**No lock**
0001	**Only SV and alarms can be set**
0010	**Only setting parameters other than alarms can be set**
0011	**Only SV can be set**
0100	**Only setting parameters other than SV can be set**
0101	**Only alarms can be set**
0110	**Only setting parameters other than SV ans alarms ca be set**
0111	**Lock of all parameters**
1000	**With COd parameter can enable the access to any programmation parameter level (see** 'Programmation parameters table'**)**

Table B

Note:also when Lock is > 0 all parameters can be showed: the lock it's relative only to setting values.

11.7 Level 3 parameters description

SL1: **Input sensor selection (see** 'Programmation parameters table**)**

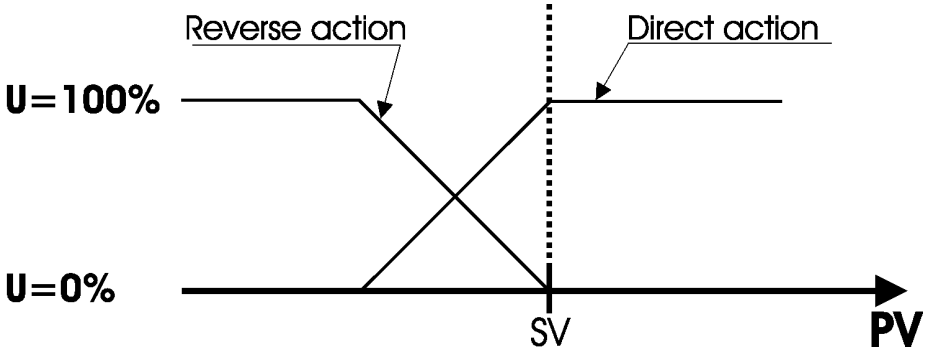
SL2: **Unit of temperature measurement (see** 'Programmation parameters table'**)**

SL3: **Reserved parameter**

SL4,SL5,SL7: Alarms parameters (see 'Alarm description'**)**

SL6: **Direct/reverse action selection; analog output offset selection (see** 'Programmation parameters table'**).**

SL6 = xxx0 à Direct action **SL6 = xxx1 à Reverse action**



Ofsset output selection:
SL6 = 011x à Regulation output 0-20mA | 0-10Volt
SL6 = 010x à Regulation output 4-20mA | 2-10Volt

Type of output (read only):
SL6 = x0xx à Regulation output: relay or logic 0-15Vcc
SL6 = x1xx à Regulation output: continuous Volt o mA

SL8: Manual regulation selection / Enable serial interface

SL8 = 0xxx: When the instrument can switch on manual mode, the manual output at the power-on is always 0%.
SL8 = 1xxx: When the instrument can switch on manual mode, the manual output at the power on is the last manual output set before power-off.

SL8 = xx0x: The instrument regulation it's only automatic
SL8 = xx1x: The user can select by <M/A key either regulation: manual or automatic. On manual mode will be the user to set the right output to achieve the set point. For more infromation see 'Auto/Man and Man/Auto regulation swicth'.

SL8 = x0xx: Serial communication disabled
SL8 = x1xx: Serial communication enabled: the instrument can be integrate in a modbus network

SLA: Digital input functions selection
SLA = 0000: No function liked to digital input
SLA = 0001: Swich from SV and SP2. Contact close: the second set point (SP2) is active. Contact open: the main SV is active.
SLA = 0010: Automatic / manual regulation switch. Contact closed: manual regulation with start output = 0%. Contact open: automatic regulation. <u>This functionality it's valid only when the parameter SL8 = xx1x.</u>
SLA = 0011: Keyboard lock. Contact close: keyboard lock. Contact open: the user can change the parameters by keyboard

SLb: Enable Ramp set point
SLB = 1xxx Set point ramp enabled
SLB = 0xxx Set point ramp disabled
See also Chapter 11.11

11.8 Level 4 parameters description

SPH,SPL: For thermocouple and RTD input sensor, these parameters are the higher (SPH) and lower (SPL) set point limitation.

For linear input signal these parameters are either the set point limitation but also the maximum and minimum linearization values.
For example: with 0-10Volt input sensor and SPL = 0, SPH = 1000, so when the input signal will be 0 over PV display will be show 0; when the input signal will be 5V, over PV display will be show 500; when the input signal will be 10V, over PV display will be show 1000.

dP: Decimal point
With this parameter the user can select the decimal point position. For thermocouple and RTD input sensor the value can change from 0 to 1; fro linear input signal the decimal point can be changed from 0 to 3.

oH: ON-OFF Hysteresis control. See 'ON-OFF regulation'. For thermocouple and RTD input sensor this parameter it's always on tenth/degree (xxx.x).

AH1,AH2: Threshold alarms hysteresis. See 'Alarms description'. For thermocouple and RTD input sensor this parameter it's always on tenth/degree (xxx.x).

ArP: Autotuning Set point %. See 'Level 2 parameter description'

dF: Filter. Active only when PV value it's near SV value.

11.9 Level 5 parameters description

Poo: PID output offset. This parameter add a fixed offset to regulation output. Any time the user change this parameter have to power off then power on the instrument to see the effect.

oPL: Regulation output limitation. This parameter clamp the maximum output value either on automatic or manual regulation.

Add: Modbus serial address. Any modbus instrument have to be a different address over network; 0 means that the instrument don't communicate (Serial communication OFF).

bPS: Baud rate (bit/seconds). Any network modbus instrument could have the same baud rate. For the possible baud rate see table on 'Menu level 5'

biF: Parity bit. The user can select from parity bit as none/odd/even. Any network modbus instrument could have to the same parity bit.

inr: Modbus sync. time (milli-Seconds): elapsed time from the master request end to slave answer. This parameter could be used to syncronize the communication when over network there are different kind of instruments.

11.10 Level 6 parameters description

SP2: Second Set point. The user can activate this set point by a digital input function (see SLA parameter description).

SR: Ramp Set point time (1-9999 minuts)

11.11 Ramp function

The ramp function it's available only from firmware version 1.2 (and higher). To know wich is the instrument firmware version see chapter 'HW e SW show version'.

The ramp function allows sudden variations to be reduced in the process in the face of changes in the setpoint; with SR parameter the user can select the ramp slope.

Example: SR = 15 minuts, actual PV value = 150°C. If the user change the set point to 250°C then the instrument will start a ramp from 150°C (the ramp start always from actual PV value) to 250°C with a positive gradient of 6,6°C/minut (250-150/15= 6,6); so at any minuts the set point increase of 6,6°C up to 250°C. The ramp will stop after 15 minuts.

SLb: 1xxx: Ramp enabled
0xxx: Ramp disabled

It is possible set two different ramp type: one-shot and continuous. Moreover it's possible define if the ramp have to start at any instrument power on.

One-shot type
SLB = 1001
In One-shot mode the ramp function run only one time when the user change the set point; at the end of ramp the parameter SLB = 1000. On this situation any Set point changing don't start any new ramp; to start a new ramp the user have to set again SLB = 1001 and re-change the set point value.

One-shot type with start at the power on off instrument
SLB = 1100
On this mode (one-shot + start at power on) at any instrument power on the ramp start from PV value to SV value with a 'Ramp time' value; this functionality is used for a soft-start system.

Continuous type

SLB = 1010
On this mode the ramp will start at any Set point changing.

Continuous type with start at the power on off instrument
On this mode the ramp will start at any Set point changing and at any instrument power on.

Active Ramp function indication
The decimal point blinking on first right SV display means that the ramp is active.

Switch from SP and SP2 by digital input
The ramp start also when the user change the set point (SV<->SP2) by digital input.

Ramp & exceptions
If during ramp mode the sensor broke or go on over or under range, the ramp stop immmediatly.

To stop/disable the ramp the user have to set SLB = 0000.

During tuning it's not possible activate a ramp.

During a ramp it's not possible start the autotuning procedure.

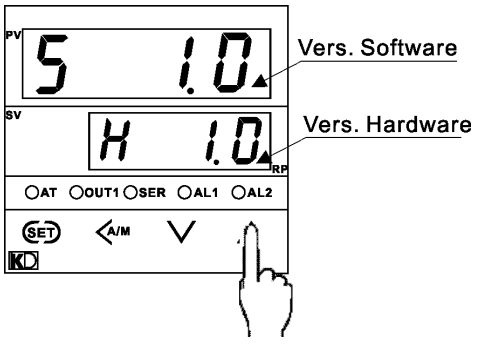
The ramp can start only if the gradient is lower than 10digits/seconds.

Example:ST=1minut(60seconds), PV=12.0°C, SV=50.0°C. The gradient will be SV-PV/ST = 500-120/60 = 6,3digits/second, so the ramp CAN start.

Example:ST=1minut(60seconds), PV=12.0°C, SV=74.0°C. The gradient will be SV-PV/ST = 740-120/60 = 10,3digits/second, so the ramp CAN NOT start.

12 HW and SW show version

To see the Hardware and software version, power on the instrument with DOWN key pressed.



13 Display at error occurrence

Err (blinking)	**EEprom failure (incorrect set data write, ecc..)** ***Action: Please contac your reseller***
OOOO (blinking)	**OverRange / sensor broke / Not wired sensor / wrong sensor wirement** **Measured value (PV) exceeds the high input display range limit.** ***Action:Chek the sensor wirement, check the process temperature, and check the sensor with a professional calibrator*.**
UUUU (blinking)	**UnderRange / wrong sensor wirement** **Measured value (PV) exceed the low input display range limit.** ***Azione: Chek the sensor wirement, check the process temperature, and check the sensor with a professional calibrator***

14 RS485 serial interface with MODBUS-RTU protocol communication

The MODBUS (RTU or ASCII) protocol is a very popular standard for field bus applications: it is ideal for reliably and efficiently handling large data flows with numerous variables. Thanks to this standard, the Evo Ser series can be hooked up directly to the majority of commercially available PLC's and SCADA packages, with the option to connect these modules together with other devices (PLC's, operator panels, CNC equipment, etc...) over a single network.

CH series devices are equipped with an RS-485 serial port with 2 wire connection; please see relative chapter for wirement.
The RS485 serial interface is galvanically isolated (2,5KVolt): if the master unit is equipped with an RS232 serial interface, we recommend using an isolated converter. If the master unit is equipped with an RS485 port, we recommend using an RS485 galvanic separator.

14.1 Communication cable layout

To prevent external interference with the serial signal and obtain the highest efficiency between the master and the CH series devices, a number of small precautions must be observed.
The most important (and simplest) is to physically separate the power and communications cables and route them as far as possible from contactors, electromagnets, powerful motors, etc.
The type of cable used is essential to the operation of the system as a whole. The most important specification is capacitance per metre (pF/m); the lower the capacitance of the cable the longer the line may be. In this regard, the power cable and generic ducting cables are absolutely to be avoided inasmuch as they have a very high capacitance per metre. Furthermore, to obtain high resistance to disturbances, the cables must be twisted together and equipped with a metal shield connected to a good ground plant (at one end only), with a characteristic impedance of around 120 ohm.
If these simple precautions are observed, the line will operate at its highest possible speed over a distance of up to 1,200 metres.
The two devices (master and last slave) at each end of the line must be terminated; star type connections are not allowed, since each wire would be terminated, thus significantly lowering the impedance of the line and blocking communications completely.

14.2 Guide to RS-485 network

The RS485 serial interface is based on a balanced differential communications line with typical impedance of 120 ohm. The maximum cable run is not defined, but depends on the speed of communications, the signal noise ratio and the quality of the cable used. The line is generally guaranteed to operate up to 1,200 m.
The cable can be unshielded if the run is of a few metres in an electrically only slightly noisy area. For distances from 15 to 100 m, you can use a shielded

and twisted cable without special characteristics, while for connections over 100 metres, we recommend using a category 5 cable.
The ends of the line must be terminated in parallel with a 120 ohm resistance.
The shield of the cable must be connected to pin Nr.13 (SG) on the CH connector, and grounded at one end only; if the other end must be grounded to reduce disturbance, fit a 10nF capacitor.

14.3 Capacitive load of the line

With very long cables, the capacitance of the cable starts to be the dominant factor in power consumption. For this reason, it is not usually possible to achieve maximum cable run and highest transmission speed in a single installation.
The following table is a rough guide to the compromise between distance and speed

Baud Rate	Total max. capacitance of cable (pF)
2.400	200.000
4.800	100.000
9.600	50.000
19.200	25.000

The capacitance of the cable (in pF/m) can be obtained from the manufacturer, and is typically between 50pF/m (for high quality cables, e.g. category 5) and 100pF/m.
Naturally, the resistance and inductance of the cable, which may be neglected for short cable runs, influence the signal level if the cable run is very long. It is hard to give general rules, since he minimum section depends on the line termination, number of connected devices and spacing between them. In case of doubt, always choose the larger section cable.

14.4 Line polarity

As per the RS485/422 standard, the line connections are indicated as A and B: the line may however be marked differently, for example HI/LO or +/-. It is usually assumed that A/B correspond respectively to HI/LO, or +/-, but this is not always the case. In case of malfunction, try swapping the connections even if everything seems to be OK.

15 Modbus RTU

15.1 Preliminary notes

MODBUS was used primarily in industrial applications, thanks to the dominating presence of Modicon in the PLC market, which developed the standard for its own equipment.
When the specifications became public and open, the Modbus protocol was adopted in numerous automation applications and subsequently in all sectors.
For many years it has been a *de facto* standard, and the Modbus protocol can be found on any "intelligent" equipment (IFD - Intelligent Field Device): programmable controllers, NC, drivers, man/machine terminals, measurement equipment, etc.

15.2 Communication model

The connection is made over an RS-485 multipoint network, typically by means of a twisted two-wire cable with shielding.
The communications technique is of the Master-Slave type, multipoint half-duplex, in which only the Master (typically a Host PC) can initiate communications with a request ("Query"), while the Slaves respond with a message ("Response") only to the queries addressed directly to themselves.
One master can control up to 247 slaves on a single line; note that this is a logical limit of the protocol, however the physical interface may further limit the number of devices, for example, the standard RS-485 interface supports a maximum of 31 slaves on a single line. If we replace the last device on the line with a bridge or repeater, a further 31 slaves can be installed, an so on up to the logical limit.
The Modbus protocol establishes the format of the query, which contains the address of the slave being queried, a function code for the requested action, various fields for exchanging data (registries, coils, etc...), and a field to check for communications errors (CRC).
The slaves respond with messages which are structured in the same way; if a slave is unable to complete the requested action, it sends an error code in the response.

15.3 Transmission

The CH series devices employ the RTU Modbus protocol; the serial mode and setup must be the same for all devices on the Modbus network.

In RTU (Remote Terminal Unit) mode, the messages, which are composed of single bytes, are sent in the form of two 4 bit hexadecimal characters. The advantage of this is that the quality of data exchange is better than that provided by the ASCII mode for a given transmission speed. Each communications packet must be transmitted in a continuous cycle.

The format for each RTU mode byte is:

Coding system: 8 binary bits, from 00 to FF
Two hexadecimal characters are contained in each 8 bit field of the message. Each 8 bit character of the message corresponds to one data byte.

Character format:
1 start bit ,
8 data bits,
the 1st bit is the least significant,
no parity bit (None),
1 stop bit.

Address: Modbus transactions always involve the master, which controls the line, and one slave at a time (except for broadcast messages, but these are not implemented in the Ch series firmware). To identify the target of the query, the first byte contains the numerical address of the desired slave. Each slave has a unique address number which uniquely identifies it. Legal addresses run from 1 to 247, while 0, which cannot be assigned to a slave, at the head of a message identifies the message as "broadcast", directed at all slaves at the same time. Only messages which do not require a response to complete may be transmitted as broadcast, in other words, only assignments.

Function code:
The second character of the message identifies the function to be executed, to which the slave responds with the same code to indicate that the function has been executed. The Evo Ser system implements a subset of Modbus functions, including:

Modbus function code	*Function*
01	Read Coil status
02	Read Input Status
03	Read Holding register
04	Read Input register
05	Force single Coil
06	Preset single register
07	Read Status

In the CH series devices, functions 01 and 02 are operatively identical and interchangeable, as are functions 03 and 04.

15.4 CRC16

The CRC field is the last in the section and allows the master and the devices to detect transmission errors. Occasionally, due to electrical noise or interferences of another kind, some modification may be caused in the message while it is being transmitted. CRC control of errors ensures that the receiver devices or the master will not perform incorrect actions due to an accidental modification of the message.

The CH controller does NOT send any reply when it detects a CRC error in the section received.Stop bits and parity bits are not considered in calculating the CRC. Only the data bits.

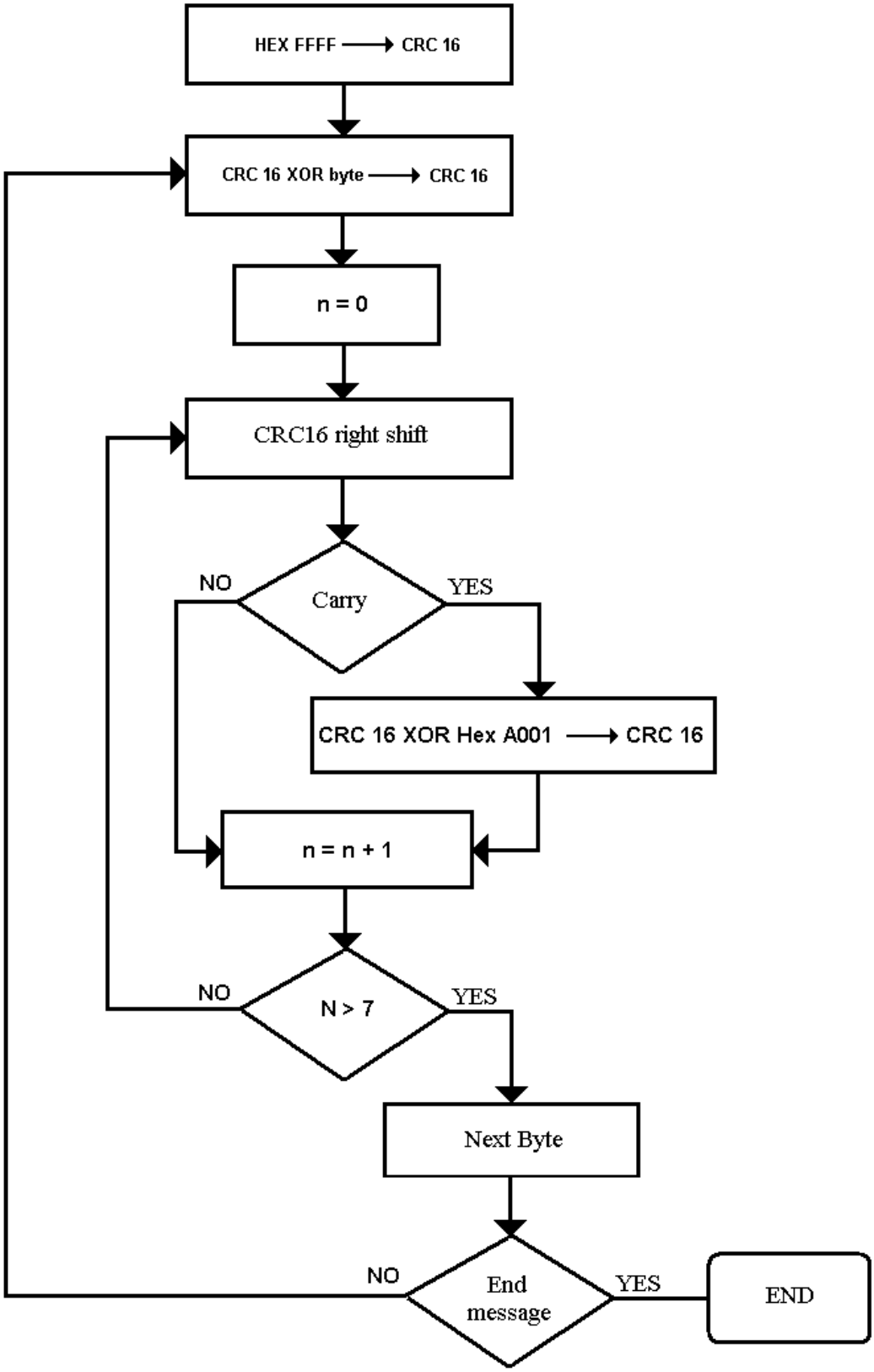
The sequence for the CRC calculation is described in the following:

1. **Load a 16 bit register at 1's.**
2. **Perform an exclusive OR of the first 8 bits received with the high byte of the register, saving the result in the register.**
3. **Move the register one bit to the right.**
4. **a) If the displaced bit is a 1, carry out an exclusive OR of the value of 1010 0000 0000 0001 with the content of the register and save it in the register.**
4. **b) If the displaced bit is a 0, return to step 3.**
5. **Repeat steps 3 and 4 to 8 bit displacements.**
6. **Carry out an exclusive OR of the following byte of the section with the 16 bit register.**
7. **Repeat steps 3 to 6 until all of the bytes of the section have been processed.**
8. **The content of the 16 bit register is the CRC, which is added to the message with the most significant bit first.**

15.4.1 CRC16 Visual Basic example

```
Function CRC16(Stringa As String) As String

        Dim N As Integer, I As Integer, NByte As Integer
        Dim CRC As Long, a As Byte
Dim Buffer As String

NByte = Len(Stringa)
CRC = 65535

    For i = 1 To NByte
       a = Asc(Mid$(Stringa, I, 1)) 'C(I)
      CRC = (CRC Xor a) And &HFFFF

       For N = 0 To 7

          If CRC And 1 Then
               CRC = (CRC \ 2)
             CRC = (CRC Xor 40961)
          Else
             CRC = CRC \ 2
          End if

       Next

    Next

    Buffer = Right$("0000" + Hex$(CRC And &HFFFF), 4)
CRC16 = Chr$ ("&H"+ Right$(Buffer, 2)) + Chr$("&H" + Left$(Buffer,2))
    End Function
```

15.5 CRC16 calculation flow chart



15.6 Message synchronisation

The message between the transmitter and receiver is synchronised by inserting a pause between messages of at least 3.5 times the time it takes to transmit a character; this pause therefore depends on the baud rate.
If the receiver does not receive for a period of 3.5 characters, it assumes the previous message to be complete and considers the subsequent byte to be the first of a new message, and thus an address.
The network devices constantly monitor the bus, including the silent pause. The admissible characters transmitted for all fields are 8 bit numbers, hence in the range 0 to 255.
The first transmitted field is the address of the device.
When the first field (address) has been received, each device decodes it to determine whether the message is addressed to itself.
After the last transmitted character, an interval of 3.5 characters follows to indicate the end of the current message. A new message can start immediately after expiry of this delay. The entire message frame must be transmitted continuously.
If a new message starts before the delay of 3.5 characters has expired, the receiver will consider it to be the continuation of the previous message; this generates an error, since the value of the last field (CRC) will not be valid for the combined messages.

START	ADDRESS	FUNCTION	DATA	CRC CHECK	END
T1-T2-T3-T4	1 CHAR (8 bits)	1 CHAR (8 bits)	N CHARS (n x 8 bits)	2 CHARS (16 bits)	T1-T2-T3-T4

16 Modbus functions

We describe in detail the modbus functions implemented on CH series devices.

16.1 Read N Bit (function code 01 or 02)

This function allows the user to obtain the logical values (ON / OFF) of the bits of the addressed device. The reply data are packed in bytes in such a way that the first bit requested occupies the bit of least weight of the first data byte. The following carry on so that if they are not a number that is a multiple of 8, the last byte is completed with zeros.

Master-device section:

Device address	Function code (01 o 02)	Address of the first bit		Number of bit to be read (max 255)		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

Device-master section:

Device address	Function code	Number of bytes read	First data byte	.....	Last data byte	CRC	
1 byte	1 byte	1 byte	1 byte	.....	1 byte	MSB	LSB

Example: Read 2 bits from the bit with address 2 (AL1 and AL2 status), of the controller with the address 2.

Master-device section:

Device address	Function code	Address of the first bit		Number of bit to be read (max 16)		CRC	
02	01	00	02	00	02	1C	38

Device-master section:

Device address	Function code	Number of bytes read	First data byte	CRC	
02	01	01	11	91	C0

The reply tell us that the coil with address 2 is active (value = 1) so the AL1 = ON and the coil with address 3 is NOT active (value = 0) so the AL2 = OFF. Excluding the first 2 bits the others bit are not importants.
It is possible read up to 16 bit togheters.

16.2 Read N registers (function code 03 or 04)

This function enables the user to obtain the vaues of the registers of the addressed device. These registers store the numerical values of the parameters and variables of the controller.

Master–device section:

Device address	Function code (03 / 04)	Address of first register		Number of register to be read (max 16)		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

Device–master section:

Device address	Function code	Number of byte read	Value of first register		.....	Value of last register		CRC	
1 byte	1 byte	1 byte	MSB	LSB	.....	MSB	LSB	MSB	LSB

Example: Read 2 register from the register with address 0 (Process value and Set Value), of the instrument address 1.
Master–device section:

Device address	Function code	Address of first register		Number of register to be read		CRC	
01	03	00	00	00	02	C4	0B

Device-master section:

Device address	Function code	Number of bytes read	Value of first register		Value of last register		CRC	
01	03	04	00	61	00	50	AB	D1

The reply tell us that the register 0 and 1 have respectively the hexadecimal value 0x0061 (PV = 97°C) and 0x0050 (SV = 80°C).

The maximum number of regester to be read is 16; a request of an higher number than 16, will make a frame error.

16.3 Assign a bit (Function code 05)

This function allows the user to assign the logical values (ON / OFF) of the bits of the addressed device. To deactivate the bit, 00h should be sent, and to activate it 01h or FFh. This value must be written in the most significant byte.

Master-device section:

Device address	Function code (05)	Bit address		Bit value		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

Device-master section:

Device address	Function code (05)	Bit address		Bit value		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

Example: Assign the activation status to the bit with address 5 (switch Auto/Man), of the instrument with address 1.

Master–device section:

Device address	Function code	Bit address		Bit value		CRC	
01	05	00	05	FF	00	9C	3B

Device–master section:

Device address	Function code	Bit address		Bit value		CRC	
01	05	00	05	FF	00	9C	3B

The reply indicates that the bit 5 has been activated, so the instrument is on manual control.

16.4 Assigning a register (Function code 06)

This function enables the user to modify the content of the parameters of the addressed device.

Master–device section:

Device address	Function code (06)	Register address		Register value		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

Device-master section:

Device address	Function code (06)	Register address		Register value		CRC	
1 byte	1 byte	MSB	LSB	MSB	LSB	MSB	LSB

Example: Assign the value 15 (000Fh) to address register with address 01 (Set Point), of CH instrumet with address 2.

Master-device section:

Device address	Function code	Register address		Register value		CRC	
02	06	00	01	00	0F	98	3D

Device-master section:

Device address	Function code	Register address		Register value		CRC	
02	06	00	01	00	0F	98	3D

The reply tell us that register 1 (Set Point) has received the value of 15 (15°C).

16.6 Modbus error codes

Commonly, the errors that appear during the device access and programming operations are related to the data not valid in the section. When a device detects an error of this kind, the reply to the master consists of the address of the device, the code of the function, the error code and the CRC. To indicate that the reply is an error notification, the bit with greatest weight in the function code is activated to 1.

Error code	Name	Description
01	ILLEGAL FUNCTION	Function not valid
02	ILLEGAL DATA ADDRESS	Data address field not valid
03	ILLEGAL DATA VALUE	Data field not valid

16.7 Communication times

From master request to slave answer it's possible set a delay with a range from 0 to 2000 milliseconds; this is possible by **parameter.**

17 Registers table

All the data shared by a module communicating with the Modbus protocol are mapped into tables, in which each datum is given an address.
Each datum can be of two types:
- "COIL", composed of a single bit: in the CH series implementation, these bits are logical states.
- "REGISTER", composed of 2 bytes (16 bit): the variables and parameters are coded as signed integers (notation in complement of 2) without decimal point (for example: a Process Value displayed as "25.0" is transmitted as 250). Assignment is only possible to the field admitted for each parameter; if you attempt to assign a value outside the admitted field, the CH series device will return an error message with exception code 3 and will not execute the assignment.
Assigning word values with functions 06 and 16 is only allowed for addresses in which this is possible (parameters marked "R/W" in the table).

Modbus address	Parameter symbol	Parameter description	Range	Access type
0[0x00]	-	PV (Process vale)	Rif. Tab. C	Read only
1[0x01]	-	SV(Set Point)	SPH-SPL	Read/Write
2[0x02]	SP2	Second Set Point	SPH-SPL	Read/Write
3[0x03]	-	Regulation output ‰	0-OpL	MAN: Read/Write Auto:Read only
4[0x04]	-	Active Set Point	-	Read only
5[0x05]	AL1	Threshold Alarm 1	1999÷+1999	Read/Write
6[0x06]	AL2	Threshold Alarm 2	1999÷+1999	Read/Write
7[0x07]	ATU	Auto Tuning	0-1	Read/Write
8[0x08]	P	Proportional band	0-1000	Read/Write
9[0x09]	I	Integral time	0-3600	Read/Write
10[0x0A]	d	Derivative time	0-3600	Read/Write
11[0x0B]	Ar	Integral time limitation	0-100	Read/Write
12[0x0C]	t	Cycle time	1-100	Read/Write
13[0x0D]	-	Reserved	-	-
14[0x0E]	-	Reserved	-	-
15[0x0F]	-	Reserved	-	-
16[0x10]	diF	Process value offset	1999÷+1999	Read/Write
17[0x11]	LCY	Access reserved levels	0-15	Read/Write
18[0x12]	Cod	Code reserved levels	0-15	Read/Write
19[0x13]	SL1	Sensor type selection	0-15	Read/Write
20[0x14]	SL2	Measure unit	0-15	Read/Write
21[0x15]	SL3	Reserved	0-15	Read/Write
22[0x16]	SL4	AL1 setting	0-15	Read/Write
23[0x17]	SL5	AL2 setting	0-15	Read/Write
24[0x18]	SL6	Offset and out. Action	0-15	Read/Write
25[0x19]	SL7	AL1 and AL2 Trigger	0-15	Read/Write
26[0x1A]	SL8	Auto/Man regulation	0-15	Read/Write
27[0x1B]	SL9	Reserved	-	-
28[0x1C]	SLA	Digital input setting	0-3	Read/Write
29[0x1D]	SLb	Ramp set point setting	0-15	Read/Write
30[0x1E]	SPH	Set point High limit	1998÷+9999	Read/Write
31[0x1F]	SPL	Set point low limit	1998÷+9999	Read/Write
32[0x20]	dP	Decimal point	0-3	Read/Write
33[0x21]	oH	ON-OFF Hystersis	0-1000	Read/Write
34[0x22]	AH1	AL1 Hystersis	0-1000	Read/Write
35[0x23]	AH2	AL2 Hystersis	0-1000	Read/Write
36[0x24]	ArP	% autotuining SP	0-100	Read/Write
37[0x25]	dF	Filter enable	0-1	Read/Write
38[0x26]	Poo	Output Offset	0-1000	Read/Write

39[0x27]	oPL	Output Limitation	0-1000	Read/Write
40[0x28]	SrF	Ramp time	1-900	Read/Write
41[0x29]	-	SW Version	-	Read only
42[0x2A]	-	HW Version	-	Read only
43[0x2B]	-	Reserved	-	-
44[0x2C]	-	Reserved	-	-
45[0x2D]	-	Cold junction temperature	-	Read only

17.1 Coils table

Modbus address	Parameter name	Range	Access type
0[0x00]	Over range sensor	0=OK 1= Overrange	Read only
1[0x01]	Under range sensor	0=OK 1= Underange	Read only
2[0x02]	AL1 Status	0=OFF 1=ON	Read only
3[0x03]	AL2 Status	0=OFF 1=ON	Read only
4[0x04]	Autotuning status	0=OFF 1=ON	Read/Write
5[0x05]	Auto/Man Status	0=Auto 1=Man	Read/Write
6[0x06]	Direct/reverse action	0=Direct 1=Reverse	Read/Write
7[0x07]	Impostazione Unità	0=°C 1=°F	Read/Write
8[0X08]	Digital input status	0= open contact 1= closed contact	Read only
9[0x09]	Reserved	-	-
10[0x0A]	Reserved	-	-
11[0x0B]	SET key status	0:Not pressed key 1:Key pressed	Read only
12[0x0C]	<A/M key status	0: Not pressed key 1: Key pressed	Read only
13[0x0D]	DOWN key status	0: Not pressed key 1: Key pressed	Read only
14[0x0E]	UP key status	0: Not pressed key 1: Key pressed	Read only

18 Modbus exceptions

-It's not possible read more than 16 registers/time
-It's not possible read more than 16 coils/time
-If the master ask for an address out of table, the slave will reply with the modbus error 'ILLEGAL DATA ADDRESS'
-If the master ask to write a data out of range, the slave will reply with a modbus error 'ILLEGAL DATA VALUE'
-If the master ask to write a data of a register out of modbus table, the slave will reply with a modbus error 'ILLEGAL DATA VALUE'
-If the instrument is on ON-OFF control (proportional band = 0) a write 0 will set the output disactive (OFF), a write of a value different from 0, will set the output active (ON)
-If the master try to write a only read parameter, the salve will reply with a modbus error 'ILLEGAL DATA ADDRESS'

19 SLx parameters code

On 'Parameters programmation table' the parameters from SL1 to SLB are showed in a binary way.

The binary code should be showed as follwoing:

Decimal	8	4	2	1
Binary	1	1	1	1

Example: change the input sensor to 1-5 Volt (SL1 parameter with modbus address 19). The 1-5Volt code is 1011 (see programmation parameter table):

DECIMAL	8		2	1	8+2+1 = 11
BINARY	1	0	1	1	

To change the input sensor as 1-5Volt it should be send the value 11 at the address 19.

Example: set the action as reverse and the regulation output as 4-20mA (SL6 parameter, modbus address 24). As show on programmation parameter table the reverse action have the code xxx1, the 4-20mA output have the code x10x, the the value to set will be 0101:

DECIMAL		4		1	4+1 = 5
BINARY	0	1	0	1	

20 Technical data

Power supply	**Switching 100÷240Vca 50-60Hz** **Switching 21-48Vca/dc**			
Power consumation	**7W (100Vca) / 10W(240Vca)** **4W (21Vca/dc) / 5W(48Vca/dc)**			
Operating conditions	**0÷50°C**			
Relative Humidity	**45%÷85% non-condensing**			
Altitude	**Max. 2000m.**			
Frontal protection	**IP65**			
Overvoltage category	**II**			
Pollution degree	**II**			
AD converter accuracy	**14 bit**			
Sample time	**5 time/seconds (any 250mS)**			
Measure accuracy @25°C	**0,2% F.S. for RTD input and Volt / mA linear input, 2% F.S. ±2°C for thermocouple input (automatic cold junction compensation)**			
Input	Type	Range	Ref. Normative	Input impedence
	K	**0-1372°C**	**IEC584**	**2,2MΩ**
	J	**0-1200°C**	**IEC584**	**2,2MΩ**
	R	**0-1769°C**	**IEC584**	**2,2MΩ**
	S	**0-1769°C**	**IEC584**	**2,2MΩ**
	B	**0-1820°C**	**IEC584**	**2,2MΩ**
	E	**0-1000°C**	**IEC584**	**2,2MΩ**
	N	**0-1300°C**	**IEC584**	**2,2MΩ**
	T	**0.0-400.0°C**	**IEC584**	**2,2MΩ**
	Pt100-Pt1000	**-199.9-649.0°C**	**IEC751**	**1,3KΩ**
	Volt	**0-5 / 0-10 V**	**-**	**1MΩ**
	mA	**0-20 mA**	**-**	**30Ω**
Regulation Output	**Relay SPDT**	**Max. Load: 5A@ 250Vca** **6A@125Vca**		
	Logic 15Vcc	**0-15Vcc ±20% max. 35 mA *(See Note 2)***		
	Continuous Volt	**Resolution:10bit. Min. load 1KΩ** **Short circuit protection**		
	Continuous mA	**Resolution:10bit. Max. load 500Ω** **Short circuit protection**		
Servovalve regulation	**2 Relay SPST**	**Max. Load: 3A@250Vca** **3A@30Vdc**		
Alarms	**Relay SPST**	**Max load: 3A@250Vca** **3A@30Vdc**		
Digital input	**2,5Kvolt galv.insul.Active jumping the terminals 16-17**			

Power supply for 2-wire transmitter	**24Vcc ±10% max. 25mA. Short circuit protection**
Serial interface	**RS485 2,5Kvolt galvanic insulation Max. Baud rate 19200bps Max. devive on RS485 network:247 Protocol: Modbus RTU-slave**
Memory	**All instrument parameters are stored in a non-volatile memory (EEprom)**
Control Type	**P, P.I. , P.I.D., ON-OFF (The user can exclude the derivative and integral action) Servovalve control**
Regulation	**Heating or Cooling regulation**
Certification	**CE, Rohs**

Note 2: on Hardare version 1_0 the maximum supply current is 12mA

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